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TRANSACTIONS

OF THE

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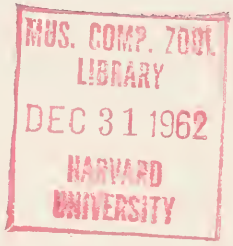

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. 12, NO. 1, pp. 1-2 MARCH 1, 1954

A NEW FORM OF PEROGNATHUS FORMOSUS FROM BAJA CALIFORNIA, MEXICO

BY

LAURENCE M. HUEY

Curator of Birds and Mammals, San Diego Society of Natural History

A study of accumulated specimens of *Perognathus formosus* in the collection of the San Diego Society of Natural History reveals an undescribed race of this species from the central, arid section of the peninsula of Baja California. It may be known as

Perognathus formosus infolatus[1] subsp. nov.

SAN FRANCISQUITO POCKET MOUSE

Type.—From 7 miles west of San Francisquíto Bay, lat. 28°30′ N., Gulf of California, Baja California, Mexico; No. 15664 collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, April 3, 1947.

Measurements of Type.—Total length 187; tail, 104; hind foot, 25; ear, 6. *Skull*: Occipitonasal length, 27.5; mastoid breadth, 14.6; interorbital constriction, 6.6; nasals, 10.2; alveolar length of upper molar series, 3.8.

[1] Lat. Bleached

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Diagnosis and *Comparisons.*—In color, *Perognathus formosus infolatus* is the most pallid, dorsally, of all the known races of *Perognathus formosus.* In this character it even exceeds the pallor of the ashen-colored *Perognathus formosus cinerascens* which inhabits the extremely arid, stony areas northward near San Felipe, Baja California, Mexico. It is larger in size than *P. f. cinerascens,* and has a proportionately greater cranium and larger, more inflated mastoid bullae.

Range.—This newly described race is known from 7 miles west of San Francisquío Bay and Barril, situated not far distant on the Gulf of California coast (lat. 28°20′ N) and from 3 specimens 2 from 3 miles west of El Mármol, and 1 from 3 miles south of El Mármol, lat. 30°. A single specimen taken on the barren rocky area northeast of El Mármol is referable to *P. f. cinerascens,* though not typical of the latter subspecies. A change in the character of the region is noticeable in the vicinity of El Mármol and is well demonstrated in the determination of these specimens. The capture of *Perognathus formosus* at Barril (28°20′ N) marks the southernmost recorded locality for this species so far.

Specimens examined. — *Perognathus formosus formosus,* 29 from Saint George, Washington County, Utah (type locality). *Perognathus formosus mohavensis,* 78 from Mohave Desert Region, California (including type). *Perognathus formosus mesembrinus,* 18 from eastern San Diego County and western Imperial County, California. *Perognathus formosus cinerascens,* 8 from San Felipe (type locality); 1 from northeast of El Mármol, Baja California, Mexico. *Perognathus formosus infolatus,* 4 from Barril; 2 from 7 miles west of San Francisquíto Bay (type locality); 1 from 3 miles south of El Mármol, and 2 from 3 miles west of El Mármol, Baja California, Mexico.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Volume XII, No. 2, pp. 3-28, plates 1-3, map

A PRELIMINARY REVISION OF THE GENUS PSELAPTRICHUS

(COLEOPTERA:PSELAPHIDAE)

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DEPARTMENT OF ENTOMOLOGY AND PARASITOLOGY

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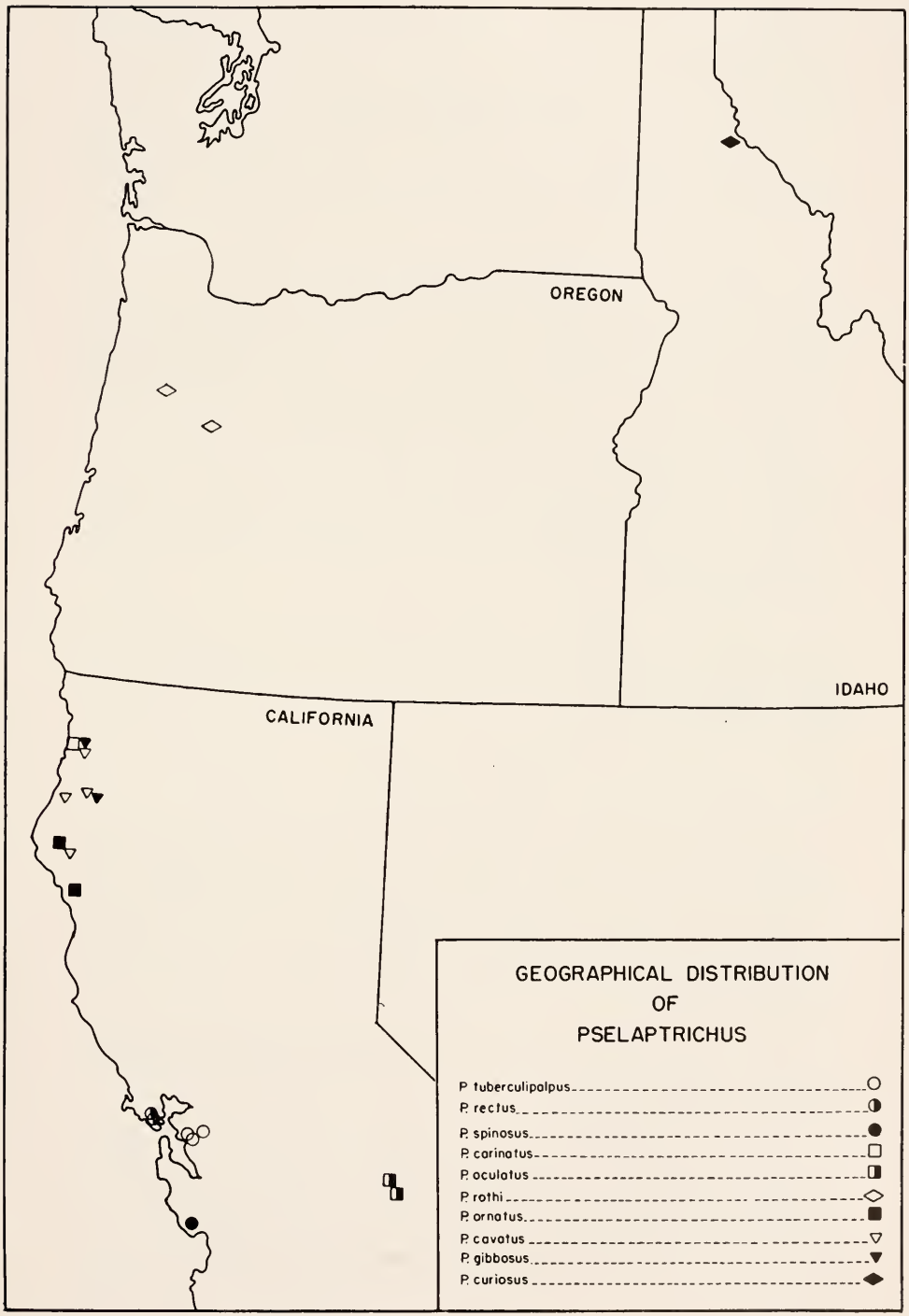

INTRODUCTION

The genus *Pselaptrichus* represents a small and poorly known group of bythinine beetles endemic to the montane regions of the western United States, and, in particular, the coniferous forests of the Pacific Coast as defined by Cain (1944, p. 110).

In such areas they usually occur in the litter and duff layers of the dark, humid forest floor. Because of such a secluded habitat and secretive nature, they were once considered to be rare as is indicated by the paucity of specimens in the major collections of the West. However, upon the exploitation of such habitats through the utilization of adequate sampling and collecting devices, it has been found, as is the case with so many specialized and "rare" organisms, that they are actually quite common and form an integral part of the western pselaphid fauna.

Prior to this paper, the genus was represented in literature by three species, two of which were recently named by Park (1953). The type species, *P. tuberculipalpus,* was described by Brendel (1889). Raffray (1908) integrated the genus with the world pselaphid fauna, while Bowman (1934) included the genus in his compilation of the Pselaphidae of North America.

This paper is designed to combine all previous information with the new material, to clarify the identity of the type species, to describe seven new species, to provide a key for the integration and recognition of all the species, and, where possible, to indicate relationships as well as variation at the specific level.

PROCEDURE

The specimens which constitute the material basis for this paper were collected during the first nine months of 1953 by the authors in conjunction with the California Insect Survey (C. I. S.), by C. D. MacNeill, E. E. Gilbert, and by other students of the Department of Entomology of the University of California whose names appear in the text. Additional specimens were loaned through the courtesy of H. B. Leech, California Academy of Sciences (C. A. S.), and Orlando Park, Northwestern University (N. U.).

Collecting methods, for the most part, were divisible into two separate activities: location of sampling sites by random sifting, and the accumulation of ground litter in paper sacks for subsequent treatment by Berlese funnels in the laboratory.

Whenever possible, specimens were mounted on both points and slides for study. Individuals to be placed on slides were cleared in warm lactophenol and mounted in either balsam or Hoyer's medium. Genitalia were removed from partially cleared specimens and mounted separately.

The descriptions of all species have been made from pointed specimens while using a binocular microscope with a magnification of 70 X, and, in certain instances, individual characters were examined on small specimens

while using 105 X. Slide mounts of specimens from the type locality were used to describe mandibular dentition.

The holotype, allotype, or both, as well as some of the paratypes, are deposited in the entomological collection of the California Academy of Sciences; the remaining paratypes in the collection of the California Insect Survey, University of California, unless otherwise indicated in the text.

The illustrations have been drawn by the authors with the aid of an ocular grid using both slide and pointed material.

MORPHOLOGY

The following discussion is based on those characters which, under the present classification, exhibit a greater degree of interspecific variation and have a certain value in species discernment. The first section deals only with those characters common to both sexes. This is followed by a discussion of secondary sexual characters.

EYES. The number of facets is one of the most variable characters in the genus, varying from four to thirty-six, with the majority of species having under twelve. This variation is particularly evident in some males where not only the number but the shape is distinctive. Those species with a small number of facets have round or subcircular eyes. As the facet number increases, the eyes become dorsoventrally elongate forming an inverted triangle as in *rothi* and *ornatus*, or become subreniform as in *oculatus*.

VERTEXAL FOVEAE. The position of the foveae in relation to the eyes has not been used in previous classifications. However, their position merits recognition as an added character in distinguishing between certain species and is particularly useful when dealing with female specimens. If an imaginary transverse line is constructed through the middle of the eyes, the foveae will lie anterior, posterior, or directly on such a line providing the head is oriented in such a manner as to be horizontally parallel to the plane of focus.

TEMPORA. In the majority of species the tempora are simply rounded or rounded angulate in dorsal outline (Pl. 2, figs. 9, 14), but in *cavatus* they form a nearly straight line to the cervix.

CERVICO-OCCIPITAL CARINA. Three species groups are segregable on the basis of this carina: those in which it does not attain the posterior border of the vertexal foveae; those in which it just attains but does not surpass the border; and those in which the carina distinctly surpasses the posterior border.

FRONTAL PROLONGATION. The median sulcus and its relation to the lateral convexities provide one means of associating males and females as this character is constant for both sexes. The sulcus may be a narrow, vestigal, canaliculate impression which is subequal in width to the lateral margins as in *carinatus*, or a broad, flat sulcus occupying a majority of the dorsal surface of the frontal prolongation, this impression being wider than the lateral margins as in *rothi*. The sulcal margins may be evenly convex, obliquely flattened forming lateral carinae, or

completely flattened and highly rugulose. They may also converge apically as in *ornatus* or diverge apically as in *rothi.*

MAXILLARY PALPI. Unfortunately little aid in classification can be obtained by using this structure to differentiate closely related species. There are, however, three basic forms of the fourth segment with minor variations of each. In two species, this segment is elongate, securiform and approximately three times longer than broad (Pl. 3, fig. 17). In all other species, this segment is approximately two times longer than broad but is of two moderately distinct forms. In some species the inner or upper margins forming the declivities are rounded angulate (Pl. 3, fig. 16). In others, the declivity of the upper apical margin is gradually rounded to the terminal palpal cone (Pl. 3, figs. 15, 18).

ELYTRA. This structure is comparable in most of the species, and yet, provides the basis for subgeneric distinction. In nine of the ten species each elytron has two antebasal foveae and a subhumeral foveae which is connected to the margin by an entire, oblique epipleural sulcus. In *curiosus,* both the subhumeral fovea and sulcus are lacking. Because of the absence of these characters *curiosus* was designated as the type species of the subgenus *Vestitrichus* Park.

ABDOMEN. The ratios of the abdominal tergites are similar in those species which are assumed to be closely related. Also, the ratio of the first tergite is inversely proportional to the total size of the species under consideration. Abdominal foveae are evident on the second sternite in all species. However, in *ornatus, cavatus* and *gibbosus* the weak apodemal invaginations at the lateral margins of both sternites and tergites which are common to those species from the central coast of California have become well developed, forming distinct pubescent foveae which are partially covered by the apical margin of each segment and are not readily visible on pointed specimens.

SECONDARY SEXUAL CHARACTERS. An accurate determination of the sexes in the genus *Pselaptrichus* is necessary not only from the practical value of the species determination, but is of considerable importance in the study of interspecific relationships. In previous classifications, the sexes were readily segregable on the basis of two morphological characters unique to the males; a preapical protibial notch or spinoid process, an apical metatibial spine, or both. With the description of several new species these two characters are insufficient to provide a positive distinction. Consequently, a combination of three anatomical landmarks as noted in the first couplet of the species key is necessary to realize a correct diagnosis.

VENTRAL SURFACE OF HEAD. In the majority of species, the ventral surface of the male head is structurally complex (Pl. 2, figs. 10-14). These structural modifications may take the form of a median carinoid process or an excavation which is occupied by various protuberances, transverse carinae, and hairs. The females of the above species lack these gross structures but have modifications of the ventral apical declivity. These modifications include a median excavation varying in size and form, and the presence or absence of a median carina, callosity, or flat deltoid impression. Both males and females of *tuberculipalpus, rectus* and *spinosus*

have a simple tumid surface without any obvious structural modifications (Pl. 2, fig. 9).

TIBIAE. The protibia of all males, with the exception of two species, possess either a spinoid process or a notch varying in form and position (Pl. 3, figs. 19, 20). The two exceptions, *rectus* and *carinatus*, have simple protibia which resemble the females in respect to this character (Pl. 3, fig. 21).

The presence of a distal metatibial spine in the males is considered to be the most valid character differentiating the sexes, though not without exception, since *carinatus* exhibits a complete loss of this structure.

ANTENNAE. The form of this structure is exceedingly similar in both sexes of most species and offers little in the way of diagnostic characters. The fourth through eighth segments are rounded hexagonal and subequal in width. However, the seventh and eighth segments of *cavatus* and *gibbosus* are dorso-ventrally compressed and longer than wide. This is noticeable in lateral aspect, appearing as a short ventral arcuation interrupting the segmental continuity.

SEX-LIMITED CHARACTERS. The eyes of the male population samples of *spinosus* and *rectus* normally have seven facets which show little intraspecific variation, and yet, two specimens of *spinosus* and one of *rectus* have twenty-five facets. Correlated with this differential number of facets is the development of presumably functional wings and associated thoracic structures which are normally lacking. Since other diagnostic characters such as the genitalia and protibia are identical, and since this dimorphism has been observed only in male specimens, it is assumed that these are sex-limited characters.

Genus Pselaptrichus Brendel

Pselaptrichus Brendel, 1889, Entom. Amer., 5: 194; Brendel and Wickham, 1890, Bull. Lab. Nat. Hist. St. Univ. Iowa, p. 242; Raffray, 1908, Genera Insectorum, fasc. 64, p. 285; Bowman, 1934, Pselaphidae of North America, Pittsburgh, privately published, p. 117; Park, 1953, Chicago Acad. Sci., Bull., 9: 255-256.

ADULT. *Head* pyriform, narrower than prothorax, widest across eyes, attenuate apically, forming frontal prolongation; prolongation porrect at apex, bearing large, approximate antennal acetabulae; disk with two nude vertexal foveae between eyes connected to frontal sulcus by oblique impressions; occiput with fine median carina of variable extent; clypeus semicircular, weakly carinate medially; labrum small, transverse, lateral angles rounded; mandibles expanded laterally at base, scrobes setate, inner ramus toothed; antennae eleven segmented; first segment elongate, cylindro-arcuate; second segment ovoid, subequal in width; third segment small, obconical; segments four through eight usually rounded-hexagonal, subequal in width; nine through eleven forming weak club; eleven obconical, larger than preceding; maxillary palpi four segmented, elongate; first segment small; second segment elongate, sinuate-clavate, coarsely tuberculate; third segment small, quadrate-tuberculate; fourth segment large, securiform, microgranulate, densely pubescent, as long or longer than second; eyes normally small, individual facets large; ventral surface of head simple or with various structural modifications. *Pronotum* sub-

cordiform, widest at apical one-third; disk with transverse, biarcuate antebasal sulcus connecting pubescent lateral foveae; procoxae confluent; mesocoxae approximate; metacoxae distant, inner proximal one-half of profemur and trochanter tuberculate; protibia simple or modified; tarsi three segmented; first minute, second elongate, longer than third; one tarsal claw or claw and accessory spine. *Elytra* widest at apex, narrowed to base; sutural striae evident; base of each elytron with two, pubescent, antebasal foveae; subhumeral foveae usually present, connected to lateral margin by oblique linear impression. *Abdomen* with five visible tergites and six sternites; tergites one through three margined laterally.

TYPE.—Pselaptrichus tuberculipalpus Brendel (monotypic).

This genus was distinct among the North American Bythinini on the basis of the fourth palpal segment which is relatively broad and about twice as long as wide. However, one new species described herein has the fourth segment three times longer than wide, thus encompassing a character often used to distinguish the eastern genus *Bythinopsis*.

The genus was recently divided into two sections by Park (1953); subgenus *Pselaptrichus sensu* Brendel (1889), containing the type species *tuberculipalpus* Brendel and *rothi* Park; subgenus *Vestitrichus* Park, containing *curiosus* Park. The seven new species described in this paper belong to the former section.

KEY TO *PSELAPTRICHUS*

1.	Ventral surface of head with obvious structural modification; or protibia excavated on inner surface; or metatibia spined apically ..... male	2
	-All of above characters absent.....female	12
2.(1)	Ventral surface of head simple.....	3
	-Ventral surface of head with obvious structural modification	5
3.(2)	Protibia with small notch at apical one fifth (Pl. 3, fig. 19); about 1.5 mm.; Alameda Co., Contra Costa Co., Calif. ..... *tuberculipalpus*	
	-Protibia simple or with prominent spinose projection.....	4
4.(3)	Protibia simple; about 1.5 mm.; Marin Co., Calif.....*rectus*	
	-Protibia with prominent spinose projection (Pl. 3, fig. 20); about 1.5 mm.; Santa Cruz Co., Calif.....*spinosus*	
5.(2)	Ventral surface of head with prominent median longitudinal carinoid process	6
	-Ventral surface of head otherwise modified.....	7
6.(5)	Elytron with subhumeral fovea and epipleural sulcus; protibia simple (Pl. 3, fig. 21) lacking apical metatibial spine; 1.3 mm.; Humboldt Co., Calif.....*carinatus*	
	-Without the above combination of characters.....	11
7.(5)	Eyes large, subreniform, over 30 facets; protibial notch bisected by two long setae (Pl. 3, fig. 22); winged; 1.7 mm.; Central Sierra Nevada .....*oculatus*	
	-Eyes small, less than 25 facets; protibial notch with at most short setae	8
8.(7)	Antennal segments III through VIII similar in form and size	9
	-Antennal segments VII and VIII conspicuously narrower in lateral outline	10

9.(8) Large species; total length 2.3 mm.; Oregon ..... *rothi*
-Small species; total length 1.5 mm.; Mendocino Co., Calif. ..... *ornatus*

10.(8) Tempora straight in dorsal outline (Pl. 2, fig. 11); total length 1.8 mm.; Humboldt Co., Calif. ..... *cavatus*
-Tempora angulate rounded in dorsal outline (Pl. 2, fig. 14); total length 1.8 mm.; Humboldt Co., Calif. ..... *gibbosus*

11.(6) Elytron without subhumeral fovea or epipleural sulcus; protibia excavated on inner surface; metatibia spined apically; total length 1.6 mm.; Idaho ..... *curiosus*

12.(1) Ventral surface of head shining, lacking small irregular punctures bearing fine hairs; gena with 2 oblique rows of setae (Pl. 2, fig. 9); total length about 1.5 mm.

Alameda Co., Contra Costa Co., Calif. ..... *tuberculipalpus*

Marin Co., Calif. ..... *rectus*

Santa Cruz Co., Calif. ..... *spinosus*

-Ventral surface of head shining, with irregular punctures bearing fine hairs 13

13.(12) Ventral surface of head subopaque, microgranulate, with few small irregular punctures bearing fine hairs; lateral borders of frontal prolongation longitudinally depressed, bicarinate; total length 1.3 mm.; Humboldt Co., Calif. *carinatus*

-Ventral surface of head punctate, bearing many fine hairs; total length over 1.5 mm. 14

14.(13) Ventral surface of head with apical declivity weakly impressed with a small circular median pit; eyes of 12 or 13 facets; total length 1.7 mm.; Central Sierra Nevada ..... *oculatus*
-Without the above characters 15

15.(14) Ventral surface of head with apical declivity strongly excavate with a fine median carina; total length 2.3 mm.; Oregon ..... *rothi*
-Ventral surface of head with apical declivity not carinate; total length less than 2.0 mm. 16

16.(15) Ventral surface of head with apical declivity weakly excavate; total length 1.5 mm.; Mendocino Co., Calif. ..... *ornatus*
-Ventral surface of head with apical declivity otherwise; larger species 17

17.(16) Tempora straight in dorsal outline (Pl. 2, fig. 11); ventral surface of head with apical declivity strongly excavate; with a small median longitudinal callosity; total length 1.8 mm.; Humboldt Co., Calif. ..... *cavatus*

-Tempora angulate rounded in dorsal outline (Pl. 2, fig. 14); ventral surface of head with apical declivity moderately excavate, forming a flat, median, glabrous, triangular impression; total length 1.8 mm.; Humboldt Co., Calif. *gibbosus*

Pselaptrichus tuberculipalpus Brendel
(Figs. 1, 15, 19)

Pselaptrichus tuberculipalpus Brendel, 1889, Entom. Amer., 5: 194.

Male. Head 0.28±0.01 mm. long X 0.28±0.01 mm. wide; pronotum 0.33±0.02 X 0.35±0.02; elytra 0.48±0.02 X 0.55±0.04; total length 1.47±0.01 mm.[1]

Integument shining, subimpunctate, rufotestaceus; vestiture coarse, moderately long, decumbent and sparse; transverse on head and prothorax, inserted laterally, extending medially; longitudinally parallel on elytra; shorter on venter. *Head* pyriform in dorsal outline, as wide as long; eyes small, with either five or six facets, subcircular to deltoid in outline; tempora evenly rounded to neck, moderately short, subequal to twice eye width; median cervico-occipital carina present, not prominent nor attaining posterior border of vertexal foveae; two, deep, nude vertexal foveae located anterior to transverse line drawn between middle of eyes; distance between foveae equal to that between fovea and eye; foveae connected to narrow frontal sulcus by straight shallow impressions forming inverted Y; dorsal surface of head not noticeably flattened, convex across cervico-temporal region where median carina delimits two distinct lateral callosities; frons sharply declivous in lateral outline, forming weak median carina extending to broad, semicircular clypeal margin; inner ramus of mandibles with 7 teeth; labrum large, medially bidentate, dentition corresponding to two blunt, subapical projections; ventral surface of head simple, without evident secondary sexual modifications; maxillary palpi as illustrated; fourth segment securiform, two times longer than broad; declivity of inner apical angle rounded angulate; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, as long as segments three through eight combined; II one third as long, slightly narrower, elongate oval; III through VIII subequal in width; III obconical, slightly longer than four through eight which are equal in length; IV through VIII subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse; X transverse, slightly wider than ninth; XI slightly longer than eighth, ninth, and tenth combined, wider than tenth, base ovate, apex subconical. *Pronotum* as long as wide, slightly wider than head; apical and basal margins subtruncate; apical margin subequal in width to base; lateral margin rounded, widest at apical one third, subsinuate to lateral apical angle, straight to lateral basal angle; disk weakly arcuate-convex in transverse section with two, oblique, pubescent foveae near lateral basal angles connected by biarcuate antebasal sulcus; medial portion of arcuation with small, obtuse, denticulation at inner edge. *Elytra* wider than long, as wide as pronotum across humeri; subimpunctate; disk somewhat flattened; each elytron bearing two, large, deep pubescent, antebasal foveae separated by width of one fovea; medial fovea inserted at base of entire parallel sutural stria; lateral fovea at base of shallow longitudinal impression which extends one fourth of elytral length; subhumeral foveae moderately large, pubescent, connected by oblique line to lateral apical margin forming entire epipleural sulcus; area between subhumeral and lateral foveae convex, forming subprominent humeral angle.

[1]The measurements and their deviations were based on eighteen male and twenty-six female specimens.

Abdomen slightly deflexed in lateral outline, with five visible tergites and six sternites; ratio of median tergite lengths 1.6/1.2/1.0/1.0/1.0; sixth sternite slightly concave medially. Prosternum convex anterior to procoxae; protibiae arcuate in outline with notch at distal one third on mesial face as illustrated; upper margin of notch with blunt tooth at inner two thirds; pro and mesotibiae with small apical spur, metatibia with inner apical spine. Genitalia complex as illustrated.

Female. Head 0.28±0.02 mm. long X 0.26±0.02 mm. wide; pronotum 0.35±0.03 X 0.36±0.02; elytra 0.51±0.045 X 0.59±0.04; total length 1.54±0.11 mm.

As in the male but differing in the following respects: eyes vestigial, of five facets, three setae on each gena parallel, not obliquely converging; prothoracic tibia simple, without inner distal notch; metathoracic tibia lacking distal spine but with small movable spur.

Type locality.—Alameda County, California.

Type deposition.—Philadelphia Academy of Natural Sciences.

Recorded distribution.—Alameda County, California (Brendel, 1889).

New records.—California.—ALAMEDA CO.: 2♂, no date (Fuchs, CAS); Oakland. 4♂, 5♀, I-28-53 R. O. Schuster (CIS); 1♂, 1♀, I-30-53 R. O. Schuster (CIS); 4♂, 3♀, II-5-53 R. O. Schuster (CIS); 1♂, 1♀, II-8-53 R. O. Schuster (CIS); 2♂, II-12-53 R. O. Schuster (CIS); 3♂, 5♀, II-13-53 W. C. Bentinck (CIS); 3♀, X-17-53 R. O. Schuster (CIS); CONTRA COSTA CO.; *Mt. Diablo*, 2♂, 6♀, II-15-53 G. A. Marsh (CIS); 4♂, 4♀, II-23-53 R. O. Schuster (CIS); Redwood Park, 2♂, 3♀, V-18-53 E. E. Gilbert, R. O. Schuster (CIS); 1♂, V-28-53 E. E. Gilbert (CIS).

The male of *tuberculipalpus* differs from all the other species in the genus by its simple, tumid, ventral surface of the head, a pre-apical notch on the inner surface of the protibia, and its small size. The female is indistinguishable from the two most closely related species, *spinosus* and *rectus*, which occupy areas immediately to the south and north of *tuberculipalpus* (see map).

Pselaptrichus rectus new species
(Fig. 2)

Male. Head 0.29 mm. long X 0.26 mm. wide; pronotum 0.32 X 0.34; elytra 0.49 X 0.54; total length 1.56 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture coarse, moderately long, decumbent and sparse; transverse on head and prothorax, inserted laterally, extending medially; longitudinally parallel on elytra; shorter on venter. *Head* pyriform in dorsal outline, longer than wide; eyes small, with six facets, subcircular in outline; tempora evenly rounded in outline, moderately short, subequal to twice eye width; median cervico-occipital carina present, not prominent nor attaining posterior border of vertexal foveae; two, deep, nude vertexal foveae located anterior to transverse line drawn between middle of eyes; distance between foveae equal to that between fovea and eye; foveae connected to narrow frontal sulcus by straight shallow impressions forming inverted Y; dorsal surface of head not noticeably flattened, convex across cervico-temporal region where median carina delimits two distinct lateral callosities; frons sharply declivous in lateral outline, forming weak median carina extending to broad, semicircular clypeal margin; inner ramus of mandibles with 6

teeth; labrum large, medially bidentate, dentition corresponding to two blunt, subapical projections; ventral surface of head simple, without evident secondary sexual modifications; maxillary palpi as in *tuberculipalpus;* fourth segment securiform, two times longer than broad; declivity of inner apical angle rounded angulate; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, as long as segments three through eight combined; II one third as long, slightly narrower, elongate oval; III through VIII subequal in width; III obconical, slightly longer than four through eight which are equal in length; IV through VIII subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse; X transverse, slightly wider than ninth; XI slightly longer than eighth, ninth, and tenth combined, wider than tenth, base ovate, apex subconical. *Pronotum* wider than long, slightly wider than head; apical and basal margins subtruncate; apical margin subequal in width to base; lateral margin rounded, widest at apical one third, subsinuate to lateral apical angle; disk weakly arcuate-convex in transverse section with two, oblique, pubescent foveae near lateral basal angles connected by biarcuate antebasal sulcus; medial portion of arcuation with small, obtuse, denticulation at inner edge. *Elytra* wider than long, as wide as pronotum across humeri; subimpunctate; disk somewhat flattened; each elytron bearing two, large, deep, pubescent, antebasal foveae separated by width of one fovea; medial fovea inserted at base of entire parallel sutural stria; lateral fovea at base of shallow longitudinal impression which extends one fourth of elytral length; subhumeral foveae moderately large, pubescent, connected by oblique line to lateral apical margin forming entire epipleural sulcus; area between subhumeral and lateral foveae convex, forming subprominent humeral angle. *Abdomen* slightly deflexed in lateral outline, with five visible tergites and six sternites; ratio of median tergite lengths 1.6/1.2/1.0/1.2/1.0; sixth sternite slightly concave medially. Prosternum convex anterior to procoxae; protibia nearly straight in outline, without a notch or spinoid process at distal one third on mesial face, simple; metatibia with inner apical spine. Genitalia complex as illustrated diagrammatically.

Female. Head 0.26 mm. long X 0.24 mm. wide; pronotum 0.31 X 0.33; elytra 0.46 X 0.53; total length 1.47 mm.

As in the male but differing in the following respects: eyes vestigial, of four facets; protibia simple as in the male; metathoracic tibia lacking distal spine.

Type materials. Holotype male and allotype female deposited in the entomological collection of the California Academy of Sciences, taken at Alpine Lake, Marin County, California, June 18, 1953 (C. D. MacNeill, R. O. Schuster). Two additional paratypes were collected at the same locality and date and are deposited in the collection of the California Insect Survey, University of California. Two specimens not designated as paratypic are from Mill Valley, Marin County, California, June 14, 1952 (H. B. Leech).

P. rectus is the second of three closely related species in which the females prove to be indistinguishable. The males however, unlike *tuberculipalpus* and *spinosus,* have the protibia simple, nearly straight, and without a trace of either a notch or a spinoid process. This, plus the lack of any structural modifications of the ventral surface of the head, will distinguish this species from any other in the genus. The protibia of

carinatus from Humboldt County, California, also has a simple protibia, but *rectus* has a metatibial spine which is lacking in *carinatus*.

Pselaptrichus spinosus new species

(Figs. 3, 9, 20)

Pselaptrichus tuberculipalpus, Park, 1953, Bull. Chicago Acad. Sci., 9: 261 (*nec* Brendel, 1889)

Male. Head 0.31 mm. long X 0.28 mm. wide; pronotum 0.33 X 0.33; elytra 0.51 X 0.58; total length 1.48 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture coarse, moderately long, decumbent and sparse; transverse on head and prothorax, inserted laterally, extending medially; longitudinally parallel on elytra; shorter on venter. *Head* pyriform in dorsal outline, longer than wide; eyes small, with either seven or eight facets, subcircular in outline; tempora evenly rounded to neck, moderately short, subequal to twice eye width; median cervico-occipital carina present, not prominent nor attaining posterior border of vertexal foveae; two, deep, nude vertexal foveae located anterior to transverse line drawn between middle of eyes; distance between foveae equal to that between fovea and eye; foveae connected to narrow frontal sulcus by straight shallow impressions forming inverted Y; dorsal surface of head not noticeably flattened, convex across cervico-temporal region where median carina delimits two distinct lateral callosities; frons sharply declivous in lateral outline, forming weak median carina extending to broad, subtruncate clypeal margin; inner ramus of mandibles with five blunt teeth; labrum large, medially bidentate, dentition corresponding to two blunt, subapical projections; ventral surface of head as illustrated, without evident secondary sexual modifications; area around tentorial pits somewhat coriaceous; maxillary palpi with fourth segment securiform, two times longer than broad; declivity of inner apical angle rounded angulate; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, as long as segments three through eight combined; II one third as long, slightly narrower, elongate oval; III through VIII subequal in width; III obconical, slightly longer than four through eight which are equal in length; IV through VIII subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse, slightly wider than eighth; X transverse, slightly wider than ninth; XI slightly longer than eighth, ninth, and tenth combined, wider than tenth, base ovate, apex subconical. *Pronotum* as long as wide, slightly wider than head; apical and basal margins subtruncate; apical margin subequal in width to base; lateral margin rounded, widest at apical one third, subsinuate to lateral apical angle, straight to lateral basal angle; disk weakly arcuate-convex in transverse section with two, oblique, pubescent foveae near lateral basal angles connected by biarcuate antebasal sulcus; medial portion of arcuation with small, obtuse denticulation at inner edge. *Elytra* wider than long, as wide as pronotum across humeri; subimpunctate; disk somewhat flattened; each elytron bearing two, large, deep, pubescent, antebasal foveae separated by width of one fovea; medial fovea inserted at base of entire parallel sutural stria; lateral fovea at base of shallow longitudinal impression which extends one fourth of elytral length; subhumeral foveae moderately large, pubescent, connected by oblique line to lateral apical margin forming entire epipleural sulcus; area between subhumeral

and lateral foveae convex, forming subprominent humeral angles. *Abdomen* slightly deflexed in lateral outline, with five visible tergites and six sternites; ratio of median tergite lengths 1.8/1.3/1.0/1.3/1.0; sixth sternite slightly concave medially. Prosternum convex anterior to procoxae; protibia strongly arcuate in outline with large spinoid process on inner face as illustrated; metatibia with inner apical spine. Genitalia complex as illustrated diagrammatically.

Female. Head 0.29 mm. long X 0.25 mm. wide; pronotum 0.34 X 0.34; eyltra 0.53 X 0.61; total length 1.4 mm.

As in the male but differing in the following respects: eyes vestigial, of six facets; prothoracic tibia simple, without inner spinoid process; metathoracic tibia lacking distal spine.

Type material. Holotype male and allotype female deposited in the entomological collection of the California Academy of Sciences, taken in redwood litter at Ben Lomond, Santa Cruz County, California, July 5, 1953 (C. D. MacNeill). Thirteen additional paratypes were collected at the same locality and date; twenty-one paratypes at the same locality in both redwood and Douglas Fir litter, June 21, 1953 (C. D. MacNeill); three paratypes, Santa Cruz County, California, July, 1906 (F. E. Blaisdell); six paratypes, Santa Cruz Mountains, California (Koebele); two paratypes, Santa Cruz County, California (Nunenmacher); ten paratypes deposited in the entomological collection of the California Academy of Sciences; thirty-five paratypes in the collection of the California Insect Survey, University of California; two paratypes in the Park collection, Northwestern University. Two specimens not designated as paratypic are from Ben Lomond, Santa Cruz County, California, June 21, 1953 (C. D. MacNeill).

Park, 1953, in describing *rothi* and *curiosus*, utilized specimens from Santa Cruz County, California, as typical of *tuberculipalpus* for the key and species comparisons. Upon examining specimens from the type locality as well as the above mentioned locality, a discrepancy in the configuration of the male protibia was noted. It was found, after a critical examination of the genitalia and a comparison of materials with the type through the kindness of Dr. James A. G. Rehn, that *tuberculipalpus* of Park represents a new and distinct species herein described as *spinosus*.

This interesting species differs at once from *tuberculipalpus* by having a well developed spinoid process on the protibia of the males rather than a simple notch. Also, the lateral lobes of the male genital armature have three distinct setae while *tuberculipalpus* has five. At present, the females of these two species are morphologically inseparable.

Occasionally, single male specimens may occur with large eyes and fully developed wings as previously mentioned in the discussion on sex-limited characters. Until further evidence is obtained concerning such specimens, they are to be considered as conspecific with *spinosus*.

Pselaptrichus carinatus new species
(Figs. 4, 10, 21)

Male. Head 0.25 mm. long X 0.27 mm. wide; pronotum 0.30 X 0.36; elytra 0.47 X 0.52; total length 1.33 mm.

Integument shining, subimpunctate, testaceus; vestiture long, very fine, reflexed, of equal density on entire dorsum; transverse on head and prono-

tum, inserted laterally, extending medially; not parallel on elytra but converging toward median suture; shorter on venter. *Head* pyriform in dorsal outline, wider than long; eyes small, of either six or seven facets, subcircular in outline; tempora evenly rounded to neck, moderately short, equal to twice eye width; median cervico-occipital carina present, subprominent, just attaining posterior border of vertexal foveae; two, shallow, nude, vertexal foveae located slightly anterior to transverse line drawn through middle of eyes; distance between foveae equal to that between fovea and eye; foveae connected to narrow frontal sulcus by straight, somewhat deep impressions forming inverted Y; oblique impressions partially interrupted at apex by flat ridge giving bisulcate appearance to median sulcus; dorsal surface of head noticeably flattened, slightly convex across cervico-temporal region; frons sharply declivous in lateral outline, forming weak median carina extending to narrow elliptical clypeal margin; labrum large, subtruncate, weakly bidentate medially; inner ramus of mandibles with seven teeth; ventral surface of head complex as illustrated, with an obliquely truncate, medial carinoid process bisetose at both apices; maxillary palpi with fourth segment securiform, two times longer than broad; declivity of inner apical angle obliquely subtruncate to palpal cone; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, as long as segments three through eight combined; II one third as long, slightly narrower, rounded rectangular; III through VIII subequal in width; III obconical, slightly longer than four; IV through VIII equal in length, subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse, X transverse, slightly wider than ninth; XI subconical, wider than tenth, slightly longer than seventh through tenth combined. *Pronotum* wider than long, slightly wider than head; apical and basal margins subtruncate; apical margin narrower than base; lateral margin widest at apical one third, evenly rounded, subsinuate to lateral basal angle; disk weakly arcuate-convex in transverse section with two, oblique, pubescent foveae near lateral basal angles; foveae connected by biarcuate antebasal sulcus; medial portion of arcuation with small, obtuse denticulation at inner edge. *Elytra* wider than long, as wide as pronotum across humeri; subimpunctate; each elytron bearing two, large, deep, pubescent antebasal foveae separated by width of one fovea; median foveae inserted at base of entire parallel, sutural striae which rapidly converge at apical one fifth; lateral fovea at base of shallow longitudinal impression; subhumeral fovea large, pubescent, connected to lateral apical margin by line forming entire epipleural sulcus; area between subhumeral and lateral foveae evenly rounded, not noticeably convex, forming humeral angles. *Abdomen* with five visible tergites and six sternites; tergites broadly convex, reflexed in lateral outline; ratio of median tergite lengths 1.6/1.2/1.0/1.0/1.0; anterior one half of prosternum convex, basal one half flattened; protibia straight, simple as illustrated, without distal notch on inner surface; metatibia subarcuate, lacking inner distal spine. Genitalia complex as illustrated.

Female. Head 0.25 mm. long X 0.27 mm. wide; pronotum 0.29 X 0.35; elytra 0.45 X 0.53; total length 1.29 mm.

As in the male but differing in the following respects: eyes vestigial, of four or five facets, semicircular in outline; ventral surface of head

simple, without a median carinoid process, with few scattered punctures bearing fine hairs; sixth sternite evenly convex.

Type material. Holotype male and allotype female deposited in the entomological collection of the California Academy of Sciences, taken in redwood litter eighteen miles south of Klamath, Del Norte County, California, September 19, 1953 (E. E. Gilbert, R. O. Schuster). Ninety-six additional paratypes were collected at the same locality and date; twenty-two paratypes at the same locality, June 26, 1953 (G. A. Marsh, R. O. Schuster); one paratype at the same locality, June 26, 1953 (J. D. Lattin); thirty paratypes desposited in the California Academy of Sciences; eighty-eight paratypes in the California Insect Survey collection, University of California.

This species differs from all the other species in the genus by having a complete lack of the apical metatibial spine, a narrow canaliculate frontal sulcus in which the lateral margins of the frontal prolongation are bicarinate, and its very small size.

The median carinoid process of the ventral surface of the head is highly suggestive of *curiosus* from which it may be readily separated by having a well developed subhumeral fovea and no evidence of a protibial notch.

The female is most readily comparable to *tuberculipalpus* and its congeners but can be distinguished on the basis of the above mentioned configuration of the frontal prolongation.

Thus far, this species is known from only the type locality. Since numerous samples were taken to the south, it would suggest that the range of *carinatus* extends north to southern Oregon providing this species dispersal corresponds to others found in northern California.

Pselaptrichus oculatus new species
(Figs. 5, 12, 22)

Male. Head 0.33 mm. long X 0.34 mm. wide; pronotum 0.40 X 0.40; elytra 0.67 X 0.72; total length 1.74 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture fine, long, suberect, somewhat sparse; transverse on head and pronotum, inserted laterally, extending medially; longitudinally parallel on elytra; shorter on venter. *Head* pyriform in dorsal outline, slightly wider than long, narrowed apically to form wide, short, subtruncate frontal prolongation bearing medial sulcus; eyes large, of thirty-three to thirty-five facets, subreniform in outline; tempora rounded angulate, rapidly descending to neck, equal to eye width; median cervico-occipital carina present, prominent, attaining or slightly surpassing posterior border of vertexal foveae; two, deep, nude vertexal foveae located on transverse line drawn between middle of eyes; distance between foveae subequal to that between fovea and eye; foveae connected to wide frontal sulcus by weakly arcuate, shallow impressions forming inverted Y; medial sulcus flat, shining, glabrous, base wider than apex; lateral convex margins flattened, rugose; dorsal surface of head flattened though moderately convex between foveae and across cervico-temporal region where median carina delimits two weak lateral callosities; frons sharply declivious in lateral outline, forming weak median carina extending to wide, elliptical clypeal margin; labrum large, subtruncate, weakly bidentate medially; ventral surface of head complex as

illustrated; fourth segment of maxillary palpi securiform, two times longer than broad; declivity of inner apical angle rounded angulate; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, subequal to segments three through eight combined; II one half as long, slightly narrower, oval; III through VIII subequal in width; III obconical, slightly longer than following which are equal in length; IV through VIII subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse; X transverse, slightly wider than ninth; XI wider than tenth, base truncate, apex subconical. *Pronotum* as long as wide, slightly wider than head; apical and basal margins subtruncate; lateral margin evenly rounded, widest at apical one third; disk evenly convex in transverse section, with two oblique, pubescent foveae at lateral basal angles; foveae connected by biarcuate antebasal sulcus; medial portion of arcuation completely interrupted by short, longitudinal carina. *Elytra* wider than long, as wide as pronotum across humeri; punctulate at base; each elytron bearing two, large, deep, pubescent antebasal foveae; median fovea originating at base of entire sutural stria; lateral fovea at base of shallow longitudinal impression; subhumeral fovea moderately large, pubescent, connected by oblique line to form entire epipleural sulcus; area between lateral and subhumeral foveae evenly convex, forming well pronounced humeral angles; sutural striae narrow, slightly converging at base and apex. *Abdomen* with five visible tergites and six sternites; broadly convex dorsally; lateral margin strongly reflexed toward apex; ratio of median tergite lengths 1.3/1.0/1.0/1.57/1.7; sixth sternite transversely concave. Prosternum weakly concave before coxae; protibia weakly arcuate in outline, notched internally at apical one fifth as illustrated; notch rounded, upper lateral angle forming weak spine, upper margin bisetose medially; metatibia with prominent spine. Genitalia complex as illustrated.

Female. Head 0.33 mm. long X 0.28 mm. wide; pronotum 0.39 X 0.40; elytra 0.58 X 0.66; total length 1.66 mm.

As in the male but differing in the following respects: eyes of nine facets, oblong in outline; ventral surface of head simple, tumid, apical declivity with small median pit; wingless; protibia without subapical notch; metatibia lacking inner apical spine.

Type materials. Holotype male, allotype female, and one paratype deposited in the entomological collection of the California Academy of Sciences. Holotype from Wawona, Mariposa County, California, June (A. Fenyes); allotype from Sugar Pine, Fresno County, California (A. Fenyes). One dissected male paratype from Wawona deposited in the California Insect Survey collection, University of California.

This species differs from typical specimens of all the other species in the genus by having large, subreniform eyes composed of over thirty facets, wings, and the characteristic ventral surface of the head.

The female exhibits a similarity of gross structure to *rothi*, but can be distinguished on the basis of the medial sulcus of the frontal prolongation which is considerably narrower than in *rothi*. Also, the apical declivity of the ventral surface of the head has a median pit rather than an excavation with a fine median carina as in *rothi*.

Thus far, this is the only species found in the Sierra Nevada range. Since those species which exhibit morphological similarities are from Oregon and northern coastal California, it would seem possible that

several other species will be found extending north into the southern Cascades.

Pselaptrichus rothi Park

Pselaptrichus rothi Park, 1953, Chicago Acad. Sci., Bull. 9: 256-257, (Pl. 1B; 2AF; 3C).

Male. Sulcus of frontal prolongation wider than long; eyes of fourteen facets, dorso-ventrally triangular in outline; tempora rounded angulate; antennal segments III through VIII similar in size and form; ventral surface of head with evident structural modification; protibia distally excavate at inner distal surface; metatibia spined distally; total length 2.3 mm.

Female. Eyes subcircular, of eight facets; ventral surface of head simply tumid; apical declivity excavate, bearing a fine median carina; protibia simple; metatibia not distally spined.

Type locality. McDonald Forest, eight miles north of Corvallis, Oregon.

Type deposition. California Academy of Sciences.

Recorded distribution. OREGON: McDonald Forest, eight miles north of Corvallis; Cascadia (Park, 1953).

At present, *rothi* is the only species found in Oregon. Its closest affinities are with *gibbosus* and *ornatus* from northern California. Of particular interest is the similarity in the curious form of the eyes which are dorsoventrally triangular. The male of *rothi* may be distinguished by its larger size, the median sulcus of the head which is broader than long, and the tuft of hairs inserted at the apex of the tuberosity on the ventral surface of the head.

The females can be recognized by a longitudinally carinate excavation of the apical declivity on the ventral surface of the head.

Pselaptrichus ornatus new species
(Figs. 6, 13, 18, 23)

Male. Head 0.27 mm. long X 0.31 mm. wide; pronotum 0.36 X 0.38; elytra 0.55 X 0.58; total length 1.44 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture fine, long, reflexed; transverse on head and pronotum, parallel on sides of elytra, converging medially; shorter on venter. *Head* pyriform in dorsal outline, longer than wide; frontal prolongation short, broad, subtruncate apically; eyes with seventeen facets, comma shaped; tempora evenly rounded to neck, one and one half times eye width; median cervico-occipital carina prominent, slightly surpassing posterior border of vertexal foveae; two, small, shallow, nude vertexal foveae located slightly anterior to transverse line drawn between middle of eyes; foveae connected to median sulcus of frontal prolongation by two moderately deep, oblique impressions forming inverted Y; dorsal surface of head flattened anteriorly, rounded convex across cervico-temporal region; sulcus of frontal prolongation wide, flat, expanded apically, wider than lateral convex margins which are glabrous basally, rugosely carinate apically; frons sharply declivous in lateral outline, forming median carina extending to narrowly elliptical clypeal margin; labrum large, subtruncate, lateral apical margins rounded, sides strongly convergent to base; ventral surface of head complex as illustrated; fourth segment of maxillary palpi two times longer than broad;

declivity of inner basal and apical angles evenly rounded as illustrated; antennae eleven segmented; segment I cylindro-arcuate when viewed from above, as long as segments three through six combined; II one third as long, slightly narrower, obovate; III through VIII subequal in width; III obcordate, slightly longer than four through eight which are equal in length; IV through VIII subquadrate, rounded hexagonal; IX through XI forming weak club; IX transverse; X transverse, slightly wider than ninth; XI slightly longer than eighth, ninth, and tenth combined, subconical. *Pronotum* slightly wider than long, noticeably wider than head, widest at apical one-third; apical and basal margins subtruncate; lateral margins evenly rounded to apical angle, weakly arcuate to base; disk evenly convex in transverse section, with two, oblique, pubescent foveae near lateral basal angles; foveae connected by biarcuate antebasal sulcus; median basal carina extending to, but not completely interrupting antebasal sulcus. *Elytra* subimpunctate, wider than long, slightly wider than prothorax across humeri; each elytron with two, large, deep, pubescent, foveae separated by width of one fovea; median fovea originating at base of narrow, entire, sutural stria; lateral fovea at inner basal angle of humeri; subhumeral fovea large, pubescent, connected by oblique line to form entire epipleural sulcus. *Abdomen* moderately deflexed in lateral outline with five visible tergites and six sternites; ratio of median tergite lengths 1.6/1.3/1.0/1.4/1.4. Protibia arcuate with notch at inner distal one third as illustrated; metatibia with inner apical spine. Genitalia complex as illustrated.

Female. Head 0.27 mm. long X 0.28 mm. wide; pronotum 0.37 X 0.40; elytra 0.56 X 0.61; total length 1.5 mm.

As in the male but differing in the following respects: eyes of seven facets; ventral surface of head simple, tumid, apical declivity weakly excavate; protibia without notch; metatibia lacking inner apical spine.

Type materials. Holotype male, allotype female, and two paratypes deposited in the entomological collection of the California Academy of Sciences, taken in redwood litter at Hartsook Grove, Mendocino County, California, September 19, 1953 (E. E. Gilbert, R. O. Schuster). Five additional paratypes collected at the same locality and date are deposited in the California Insect Survey collection, University of California. Three specimens not designated as paratypic are from one mile south of Dyerville, Humboldt County, California, August 13, 1953 (G. A. Marsh, R. O. Schuster) and September 19, 1953 (E. E. Gilbert, R. O. Schuster).

The males of this species are closely related to *rothi* and *gibbosus* but are easily distinguished from the former by its smaller size and from the latter by the antennae, segments three through eight being subequal in width in *ornatus*.

In the females, the apical declivity of the ventral surface of the head is but weakly excavate and lacks the triangular impression of *gibbosus* and the median carina of *rothi*.

Pselaptrichus cavatus new species
(Figs. 7, 11, 17, 24)

Male. Head 0.40 mm. long X 0.33 mm. wide; pronotum 0.44 X 0.45; elytra 0.69 X 0.68; total length 1.78 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture fine, short,

decumbent, sparse, tending to become deciduous; transverse on head and pronotum; elytral pubescence longitudinally parallel; shorter on venter. *Head* elongate pyriform in dorsal outline, longer than wide; with conspicuous narrow, subtruncate frontal prolongation; eyes small, of ten facets, dorsoventrally conical in outline; tempora straight to neck, long, equal to three times eye width; median cervico-occipital carina subprominent, surpassing posterior border of vertexal foveae; two, shallow, nude, vertexal foveae located posterior to transverse line drawn through middle of eyes; distance between foveae equal to that between fovea and eye; oblique lateral sulcal connections to broad shallow median sulcus of frontal prolongation partially interrupted by converging basal lateral angles of prolongation anterior to fovea, forming weak inverted Y; dorsal surface of head noticeably flattened except for weak convexity between vertexal foveae; margin of foveae not continuous, anterior one half open; two, minute, shallow, subcircular impressions obliquely posterior to ventral margin of eyes; each bearing a long seta; frons sharply declivous in lateral outline, forming a median carina extending to narrowly elliptical clypeal margin; labrum large, subtruncate, lateral margins strongly sinuate to base; apical angles evenly rounded; inner ramus of mandibles with eight teeth; ventral surface of head complex as illustrated; maxillary palpi as illustrated; fourth segment three times longer than broad; declivity of inner apical angles obsolete, gradually attenuate to palpal cone; antennae eleven segmented; segment I cylindro-arcuate when viewed dorsally, as long as segments three through nine combined; II oval, one fourth as long, subequal in width; III through VI subequal in width; III obconical, slightly longer than four; VII dorso-ventrally compressed, longer than wide, rounded rectangular; VIII similar to four through six; IX through XI forming weak club; IX transverse; X transverse, slightly wider than ninth; XI subequal to nine and ten, subconical. *Pronotum* as long as wide, slightly wider than head, widest at apical one third; evenly rounded to lateral apical angle, nearly straight to base; apical and basal margins subtruncate; disk weakly arcuate convex in transverse section with two, oblique, pubescent foveae near lateral basal angles; foveae connected by biarcuate antebasal sulcus; median portion of arcuation with small, obtuse, medial denticulation at inner edge completely interrupting antebasal sulcus. *Elytra* subimpunctate; wider than long, as wide as pronotum across humeri; each elytron bearing two, large, deep, pubescent antebasal foveae separated by width of one fovea; median fovea inserted at base of entire sutural stria; shallow impression at base of lateral fovea obsolete, not extending apically; subhumeral fovea large, pubescent, connected by oblique line to lateral margin forming entire epipleural sulcus. *Abdomen* strongly deflexed in lateral outline; with five visible tergites and six sternites; ratio of median tergite lengths 1.3/1.14/1.0/1.57/1.4; prosternum flattened anterior to coxae, broadly emarginate along apical margin; protibia slightly arcuate to distal one fifth, with a shallow U shaped notch on inner surface; metatibia with large prominent, apical spine. Genitalia complex as illustrated.

Female. Head 0.39 mm. long X 0.33 mm. wide; pronotum 0.44 X 0.45; elytra 0.65 X 0.70; total length 1.78 mm.

As in the male but differing in the following respects: eyes of five facets, subcircular in outline; seventh antennal segment not elongate,

identical with sixth; ventral surface of head simple, apical declivity excavate with median longitudinal callosity; protibia simple, without notch on inner apical surface; metatibia without apical spine.

Type materials. Holotype male and allotype female deposited in the entomological collection of the California Academy of Sciences, taken in redwood litter at Freshwater, Humboldt County, California, August 13, 1953 (G. A. Marsh, R. O. Schuster). Four paratypes were collected at the same locality and date; ten paratypes in redwood litter eighteen miles south of Klamath, Del Norte County, California, September 19, 1953 (E. E. Gilbert, R. O. Schuster); twelve paratypes in redwood litter one and one half miles south of Dyerville, Humboldt County, California, August 13, 1953 (G. A. Marsh, R. O. Schuster) and September 19, 1953 (E. E. Gilbert, R. O. Schuster); one paratype at Green Point Ranch, Humboldt County, California, June 11, 1919 (F. E. Blaisdell). Seven paratypes deposited in the collection of the California Academy of Sciences; twenty-two in the California Insect Survey collection, University of California.

Although *gibbosus* is of comparable size, *cavatus* can be readily recognized from this or any other species in the genus by the fourth segment of the maxillary palpus which is fully three times as long as wide, or by the tempora which are nearly straight to the cervex. At present, this species cannot be compared with any other in the genus.

Pselaptrichus gibbosus new species
(Figs. 8, 14, 25)

Male. Head 0.38 mm. long X 0.33 mm. wide; pronotum 0.42 X 0.43; elytra 0.61 X 0.65; total length 1.67 mm.

Integument shining, subimpunctate, rufotestaceus; vestiture long, fine, dense, sparser on head and prothorax and transverse, inserted laterally, extending medially, decumbent; elytral pubescence longitudinally parallel at sides, converging medially toward sutural striae; shorter on venter. *Head* pyriform, slightly longer than wide in dorsal outline; frontal prolongation one half length of head, subtruncate apically; eyes small, not vestigial, with twelve facets, dorsoventrally elongate triangular; tempora rounded angulate to neck, equal to two times eye width; median cervico-occipital carina weak, not attaining line drawn between posterior border of vertexal foveae; two, deep, nude, vertexal foveae located on a line drawn through middle of eyes; foveae connected to median sulcus of frontal prolongation by shallow, oblique impressions forming inverted Y; dorsal surface of head noticeably flattened except for weakly convex area across cervico-temporal region; medial sulcus shallow, narrow, subequal to width of either lateral areas which are flattened and rugosely impressed; frons sharply declivous in lateral outline, forming median carina extending to moderately elliptical clypeal margin; labrum large, apex subtruncate, weakly bidentate medially; ventral surface of head complex as illustrated; fourth segment of maxillary palpi two times longer than wide; declivity of inner apical angle rounded angulate; antennae eleven segmented; segment I cylindro-arcuate when viewed dorsally, as long as segments three through eight combined; II obovate, one third as long, subequal in width; III obcordate, slightly longer than four; IV and V rounded hexagonal, subequal in width; VI elongate, longer than pre-

ceding; VII subequal to fourth and fifth, elongate rectangular; VIII rounded hexagonal; IX through XI forming weak club; IX transverse; X transverse, wider than ninth; XI subconical, equal to ninth and tenth combined. *Pronotum* as long as wide, widest at apical one third; sinuate to lateral apical angle, nearly straight to base; apical and basal margins subtruncate; disk weakly arcuate-convex in transverse section, with two, oblique, pubescent foveae near lateral basal angles; foveae connected by biarcuate antebasal sulcus with medial denticulation at inner edge completely interrupting sulcus. *Elytra* subimpunctate; as long as wide, as wide as prothorax across humeri; each elytron bearing two moderately large, deep, pubescent, antebasal foveae separated by width of one fovea; median fovea originating at base of entire sutural stria; shallow impression at base of lateral fovea obscure; subhumeral fovea moderately large, deep, connected by oblique line to lateral margin, forming entire epipleural sulcus. *Abdomen* strongly deflexed in lateral outline with five visible tergites and six sternites; ratio of median tergite lengths 1.3/1.4/1.0/1.14/1.2; sixth sternite weakly concave; prosternum weakly concave; protibia nearly straight, bearing sinuate notch at inner one fifth as illustrated; metatibia with a small vestigial spine. Genitalia complex as illustrated.

Female. Head 0.36 mm. long X 0.30 mm. wide; pronotum 0.40 X 0.45; elytra 0.63 X 0.66; total length 1.83 mm.

As in the male but differing in the following respects: ventral surface of head simple, microgranulate and hirsute, slightly tumid apically; apical declivity with glabrous triangular impression; antennae lacking segmental modification; eyes small, of six facets; sixth sternite flattened; protibia simple, without notch at inner distal one fifth; metatibial spine absent.

Type material. Holotype male, allotype female, and five paratypes deposited in the entomological collection of the California Academy of Sciences, taken in *Umbellularia californica* litter fourteen miles east of Blue Lake, Humboldt County, California, September 19, 1953 (E. E. Gilbert, R. O. Schuster). Ten additional paratypes were collected at the same locality and date; ten paratypes in redwood litter eighteen miles south of Klamath, Del Norte County, California, August 13, 1953 (G. A. Marsh, R. O. Schuster); and September 19, 1953 (E. E. Gilbert, R. O. Schuster); one paratype from Green Point Ranch, Humboldt County, California, June 11, 1919 (F. E. Blaisdell); twenty-one paratypes deposited in the collection of the California Insect Survey, University of California.

The affinities of this species remain uncertain because individual characters are found in common with several species, all of which have characteristic modifications of the ventral surface of the head. For example, the general facies of the male of *gibbosus* is similar to that of *ornatus* and *rothi* but differs from these species in having the sixth and seventh segments of the antennae longer than wide. This antennal character is present in the male of *cavatus,* from which *gibbosus* is easily distinguished by the rounded angulate tempora. The females of *gibbosus* can be distinguished by the glabrous triangular impression on the apical declivity of the ventral surface of the head.

Pselaptrichus curiosus Park

Pselaptrichus curiosus Park, 1953, Chicago Acad. Sci., Bull., 9(3): 258-259, (pl. 1C; 2B).

Male. Eyes of five facets, triangular in outline; ventral surface of head with high, median carinoid process; antennal segments III through VIII similar in size and form; subhumeral foveae of elytra absent; protibia excavate at inner distal margin; metatibia spined apically; total length 1.62 mm. (fide Park).

Female. Unknown.

Type locality. Avery, Shoshone County, Idaho.

Type deposition. Northwestern University, Park collection.

Recorded distribution. IDAHO: Avery (Park, 1953 a).

The authors have not seen specimens of *curiosus,* but there can be little doubt as to the validity of this interesting species since it is the only one which lacks the subhumeral foveae.

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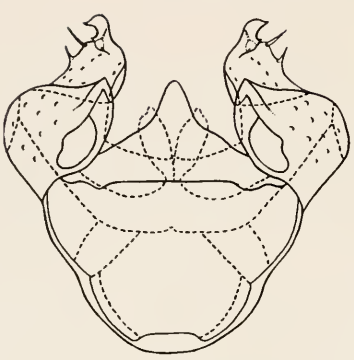

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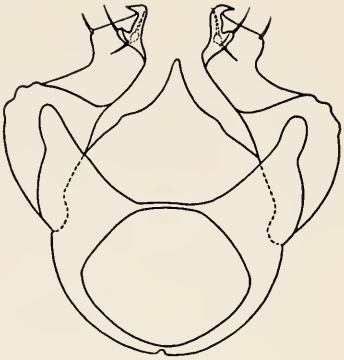

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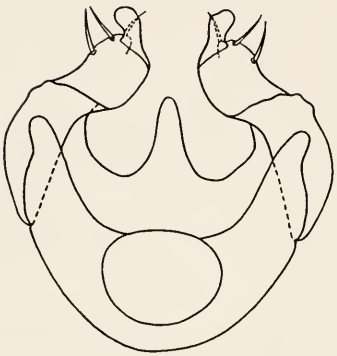

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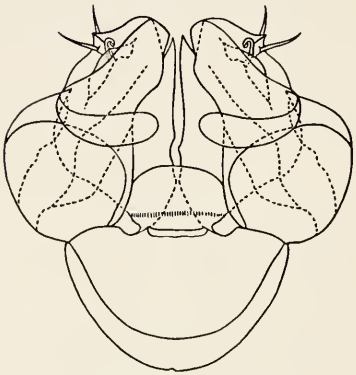
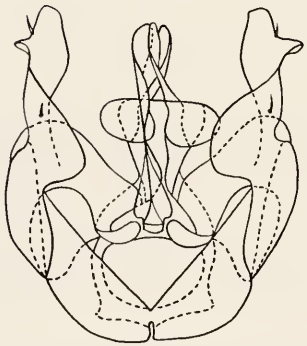


4 carinatus



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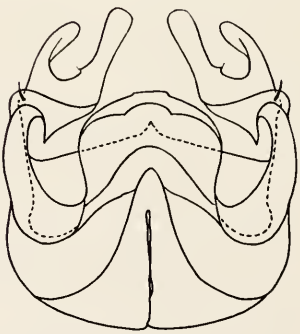
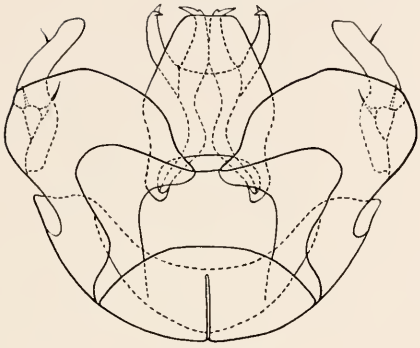


6 ornatus

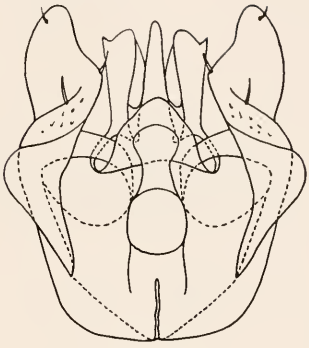
PLATE I

Male genitalia

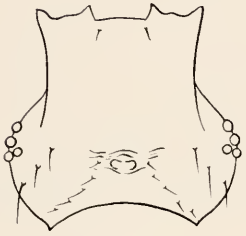
1. *Pselaptrichus tuberculipalpus* Brendel, 0.15 mm. long, 0.15 wide.
2. *P. rectus* new species, 0.15 mm. long, 0.15 mm. wide.
3. *P. spinosus* new species, 0.14 mm. long, 0.14 mm. wide.
4. *P. carinatus* new species, 0.17 mm. long, 0.17 mm. wide.
5. *P. oculatus* new species, 0.38 mm. long, 0.32 mm. wide.
6. *P. ornatus* new species, 0.16 mm. long, 0.14 mm. wide.



7 cavatus



8 gibbosus



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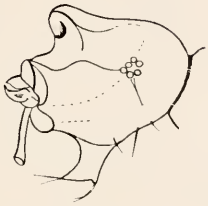
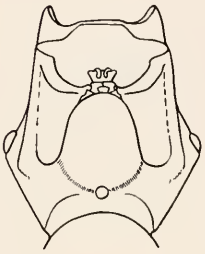


10 carinatus



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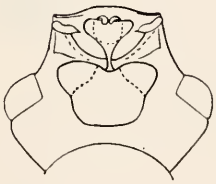
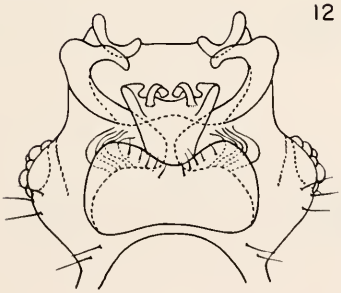
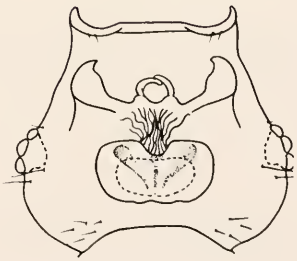


12 oculatus



13 ornatus



14 gibbosus

PLATE II

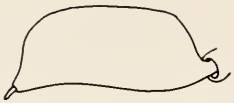
Male genitalia

7. *P. cavatus* new species, 0.31 mm. long, 0.37 mm. wide.
8. *P. gibbosus* new species, 0.26 mm. long, 0.21 mm. wide.

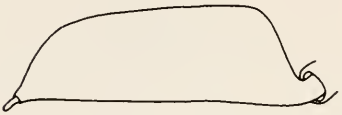
Male head

9. *P. spinosus* new species, ventral surface.
10. *P. carinatus* new species, lateral aspect.
11. *P. cavatus* new species, ventral surface.
12. *P. oculatus* new species, ventral surface.
13. *P. ornatus* new species, ventral surface.
14. *P. gibbosus* new species, ventral surface.

15 tuberculipalpus



16 carinatus



17 cavatus

18 ornatus

19 tuberculipalpus

23 ornatus

20 spinosus

24 cavatus

21 carinatus

22 oculatus

PLATE III

25 gibbosus

Right maxillary palpi, ventral aspect

15. *P. tuberculipalpus* Brendel.
16. *P. carinatus* new species.
17. *P. cavatus* new species.
18. *P. ornatus* new species.

Male prothoracic tibia

19. *P. tuberculipalpus* Brendel.
20. *P. spinosus* new species.
21. *P. carinatus* new species.
22. *P. oculatus* new species.
23. *P. ornatus* new species.
24. *P. cavatus* new species.
25. *P. gibbosus* new species.

TRANSACTIONS

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THE FOSSIL PIT-VIPERS (REPTILIA: CROTALIDAE) OF NORTH AMERICA

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INTRODUCTION

In 1920, Hay referred several fossil rattlesnake vertebrae to existent species. Later Gilmore (1938) could find no differences between the vertebrae of recent species of rattlesnakes, much less between the vertebrae of the various genera of the Crotalidae. He therefore referred all the fossil crotalids to *Crotalus* sp. except for the large vertebrae from the Pleistocene of Florida which, on the basis of size and distribution, he referred to the recent species, *Crotalus adamanteus.*

For several years the writer has been studying the comparative osteology of the rattlesnakes and their relatives and has found that not only the genera, but the species as well, can be distinguished on the basis of skull and vertebral characteristics. The results of this study will be presented elsewhere, with reasons for reaching certain conclusions as to identification of species (Brattstrom, MS.). During the study here reported the fossil crotalids in the various museums in the country have been examined. So that some of the names presented herein might be made available, this short summary of our current knowledge of the fossil rattlesnakes, copperheads, and moccasins of North America is presented.

The Crotalidae or "Pit-Vipers" are a family of solenoglyph or movable front-fanged, poisonous snakes showing remarkable parallel and convergent evolution with the Old World family of true vipers (Viperidae). The Crotalidae differ from the Viperidae in many characters, the most important of which is the heat-sensitive facial or loreal pit lying in a depression that accommodates this pit in the maxillary bone.

The Crotalidae include six genera (*Crotalus, Sistrurus, Agkistrodon, Lachesis, Bothrops,* and *Trimeresurus*), of which *Crotalus, Sistrurus,* and *Agkistrodon* are the Recent North American representatives. The extinct genera *Neurodromicus* Cope, 1873 (Miocene-Oligocene); *Helagras* Cope, 1883 (Paleocene); and *Coniophis* Marsh, 1892 (Upper Cretaceous) were assigned to the Crotalidae by Hay (1902). These genera, except *Coniophis,* were placed in the broad family Viperidae (considering the Crotalidae as a subfamily) by Williston (1925). Gilmore (1938) removed *Coniophis* and *Helagras* from the Crotalidae and placed them in *Incertae Sedis,* but retained *Neurodromicus* in the family. Vanzolini (1952) has recently shown, and the writer concurs, that *Neurodromicus* should be placed in the Boidae. The oldest known crotalids are *Crotalus viridis* and *Agkistrodon contortrix* from the ?Lower Pliocene of Driftwood Creek, Nebraska.

The writer has referred the skeletal remains of rattlesnakes from the asphalt pits and limestone caves of California to existing species (Brattstrom, 1953a, 1953b). One fossil from Potter Creek Cave, California, however, differed from recent species and was described as *Crotalus potterensis* (Brattstrom, 1953b). As other Pleistocene material containing rattlesnakes was examined, short papers were published on the herpetofauna of some of the sites. This included some material from Florida (Brattstrom, 1953c) and from Gypsum Cave, Nevada (Brattstrom, 1954). Many identifications were made on fossil material in the various museums and these are now reported. In addition, one new species and one new subspecies are described herein.

The large number of vertebrae of *Crotalus adamanteus* from many Pleistocene sites in Florida makes possible a statistical comparison with Recent material. Differences are indicated that show a gradient, or intergradation in time. This problem has faced others (Howard, 1946; Colbert and Hooijer, 1953) and they solved the problem by considering the Pleistocene form as a subspecies of the Recent form. Though many of the characteristics are obvious and qualitative, to demonstrate further the differences, the method of ratio of log-differences of a series of analogous measurements was used. This method was developed by Simpson (1941) and used to good purpose by Colbert and Hooijer (1953) in showing differences between Pleistocene and Recent subspecies of mammals from China. It has proven to be very useful in distinguishing closely related forms on the basis of vertebrae (Brattstrom, MS.).

SYSTEMATIC LIST

Agkistrodon contortrix (Linnaeus)

Nebraska, Driftwood Creek, Hitchcock County, ?Lower Pliocene. A.M.N.H. 7182, 2 vertebrae; A.M.N.H. 7185, 29 vertebrae.

These 31 vertebrae, representing the first record of fossil copperheads, do not differ from vertebrae of Recent specimens.

Agkistrodon piscivorus (Lacépède)

Florida, Seminole, Pinellas County, Late Pleistocene. A.M.N.H. 7181, 4 vertebrae.

Florida, Melbourne, Brevard County, Late Pleistocene. M.C.Z. 2111, 10 vertebrae.

Florida, Crystal Springs, 28 miles N.E. of Tampa, Pasco County, M.C.Z. 2116, 3 vertebrae.

Crotalus adamanteus pleistofloridensis, new subspecies

TYPE: A.M.N.H. Department of Vertebrate Paleontology, number 6779 (one mid-thoracic vertebra).

LOCALITY AND AGE: Seminole, Pinellas County, Florida, Late Pleistocene.

DIAGNOSIS: A *Crotalus* differing from *C. a. adamanteus* in being larger and in having a higher neural spine, a longer hypapophysis, the parapophysis longer and bent laterally, and the process of prezygapophysis wider that the process of the postzygapophysis.

DESCRIPTION OF TYPE: The holotype has a tall neural spine and an elongate hypapophysis (Figure 2). Neural spine widest at the top, zygosphene indented slightly at the middle, prezygapophysis turned up slightly. Centrum cup and ball slightly wider than high, lower part of the parapophysis (prepophysis) longer than wide, the hypapophysis elongate and flat in its posterior part, widest (anteroposteriorly) at its base. Neural canal a little higher than wide, zygantrum deep and narrow with the result that the posterior part of the postzygapophysis process is solid. Area of vertebra between the process of the pre- and postzygapophysis straight, not curved.

Comparative measurements of all known specimens of *C. adamanteus pleistofloridensis* are presented in Figure 1. Measurements in millimeters of the type (and paratype) are as follows: Height, 36.9 (35.2); width, 14.8 (15.8); length at centrum from ball to cup, 11.8 (12.8); height of neural spine, 12.1 (10.0); width of neural spine, 8.7 (9.0); height of centrum, 6.4 (6.8); width of centrum, 7.0 (7.5); width across prezygapophysis, 25.0+ (27.3); width across postzygapophysis, 24.2 (24.2+); width of prezygapophysis process, 4.5 (4.6); width of postzygapophysis process, 4.1 (4.0); length of hyapophysis, 18.8 (19.5); width of hyapophysis, 4.1 (4.3); height of zygosphene from top of cup, 7.0 (7.0); width across zygosphene, 10.2 (10.9); length of anterior parapophysis, 5.0 (5.6); width of anterior parapophysis 3.4 (3.4).

REFERRED MATERIAL: (All from the Pleistocene of Florida)
A.M.N.H. 7170, Paratype, Seminole, Pinellas County, 1 vertebra.

A.M.N.H. 6776, Seminole, Pinellas County, many vertebrae.
A.M.N.H. 6778, "Allen Cave," Lecanto, Citrus County, 6 vertebrae.
A.M.N.H. 7514, Florida, locality unknown, 17 vertebrae.
U.C. 28910, Seminole, Pinellas County, 2 vertebrae.
U.S.N.M. 13678, 2 miles W. of Melbourne, Brevard County, 19 vertebrae.
U.S.N.M. 13679, near Melbourne, Brevard County, 5 vertebrae.
U.S.N.M. 13677, near Melbourne, Brevard County, 3 vertebrae.
U.S.N.M. 11220, 2 miles W. of Melbourne, Brevard County, 3 vertebrae.
U.S.N.M. 11333, N. side Canal, Vero Beach, St. Lucie County, 46 vertebrae (figured in Gilmore, 1938, pg. 74, Fig. 31).
U.S.N.M. 11856, Melbourne, Brevard County, 12 vertebrae.
U. Mich. 1009-1010, Seminole, Pinellas County, 2 vertebrae.
M.C.Z. 2101, Melbourne, Brevard County, many vertebrae.
M.C.Z. 2112-2113, Vero Beach, St. Lucie County, 23 vertebrae.
F.G.S. V-471, Florida, locality unknown, 1 vertebra.
F.G.S. V-472, Stratum, Vero Beach, St. Lucie County, 1 vertebra.
F.G.S. V-2455, V-3472, V-2413, V-3492, V-1630, Stratum 3, Vero Beach, St. Lucie County, 10 vertebrae.

DISCUSSION:

C. a. pleistofloridensis is most closely related to the recent form *C. a. adamanteus* Beauvois from which it differs in the characters presented in the diagnosis above, but especially in its large size. The subspecies *C. a. pleistofloridensis* is extinct though it is survived directly by *C. a. adamanteus*. The extinct subspecies occurs in the many Pleistocene localities mentioned above and in association with an extinct, still larger species (described below).

Photographs of the type, paratype, and several series of *C. a. pleistofloridensis* are shown in Figure 2. A vertebra of this subspecies was figured in Gilmore (1938), as *C. adamanteus*, (Fig. 31, pg. 74) from Vero Beach, Florida.

Crotalus atrox Baird and Girard

Nevada, Gypsum Cave, Late Pleistocene-Recent (8,000 to 10,000 years) C.I.T. 94 vertebrae.
Texas, Bulverde, Bexar County, Middle Pleistocene, U.S.N.M. 9223, 10 vertebrae, 1 dentary, 1 maxilla and fang, 15 ribs.

Crotalus atrox was first found as a fossil by Hay (1920), from Texas. A vertebra from this collection was figured by Hay (1920, pl. 10, Fig. 2.), upside down. It was also figured by Gilmore (1938, pg. 73, fig. 30). The length of the fang from Texas is 11.0 mm.

Crotalus giganteus, new species

TYPE: A.M.N.H. Department of Vertebrate Paleontology number 6772 (one vertebrae).
TYPE LOCALITY AND AGE: "Allen Cave," Lecanto, Citrus County, Florida, Pleistocene.
DIAGNOSIS: A large rattlesnake related to *C. adamanteus* but differing from it in the large size of the vertebra, centrum, hypapophysis, and parapophysis, and in having the hypapophysis widest (anteroposteriorly) at its tip and not its base.

DESCRIPTION OF TYPE: A large vertebra measuring 41.2 mm. high, 17.7 mm. wide, and 13.3 mm. long at the centrum from cup to ball (Figure 2). Neural spine relatively wide, front of zygosphene even with the anterior edge of neural spine. Top of the zygosphene slanting ventrally. Centrum round, parapophysis almost as wide as long, width across prezygapophysis greater than width across postzygapophysis, process of prezygapophysis wider than process of postzygapophysis. Hypapophysis longer than height of neural spine and widely expanded at its tip. The tip of the left prezygapophysis is broken in the type. Measurements of the type (in millimeters) are as follows: height and width of neural spine, 13.7 and 11.4; height and width of centrum, 7.5 and 5.6; width across pre- and postzygapophyses 29.6 and 29.2; width of process of pre- and postzygapophysis, 5.9 and 5.1; length and width of hypapophysis, 22.9 and 5.0; height of zygosphene above centrum cup, 7.9; width across zygosphene, 11.5; length and width of anterior parapophyses, 6.9 and 5.2. PARATYPE: Besides the type there is a fragment of a vertebra (A.M.N.H. 7171) that is designated as the paratype. This fragment contains the left side of the vertebra and the centrum at its posterior end. This centrum is also round (height and width, 7.5 and 7.5 mm.).

DISCUSSION: The type and paratype are figured in Figure 2, and their measurements are compared with those of Recent *C. a. adamanteus* and Pleistocene *C. a. pleistofloridensis* in Figure 1, on a Ratio of log-difference scale.

C. giganteus most closely resembles *C. a. pleistofloridensis,* from which it differs in its much larger size and in having the hypapophysis widest (anteroposteriorly) at its tip. *Crotalus giganteus* is found in association with (and thus probably co-existing with) *C. a. pleistofloridensis* and *Lampropeltis getulus* in "Allen Cave." Recent *C. a. adamanteus* attains a maximum recorded size of 7 feet, 4 inches. Judging from the large size of *C. a. pleistofloridensis* and the much larger *C. giganteus* vertebrae, it is possible to speculate as to the maximum sizes of these forms. It is possible that *C. a. pleistofloridensis* attained a length of 9 or 10 feet, and 12 feet was probably the maximum length for *C. giganteus.* The width of *giganteus* was probably similar to that of the modern boa constrictor. The species is extinct.

Crotalus horridus Linnaeus

Arkansas, Conard Fissure, Pleistocene. A.M.N.H. 6404, many vertebrae and the posterior half of a lower jaw.
Georgia, Near Cartersville, Pleistocene, U.S.N.M. 4887, 53 vertebrae.
Maryland, Cavetown, Middle Pleistocene, U.S.N.M. 9157, 2 vertebrae.
Maryland, Cumberland Cave, Pleistocene, U.S.N.M. 13772, 11 vertebrae.
Massachusetts, ————, Pleistocene, A.M.N.H. many bones, Hecht, MS.
Pennsylvania, Carlisle Cave, Pleistocene-Recent, U.S.N.M. 102698, 4 vertebrae.
Tennessee, Big Pigeon River, near Newport, Cocke County, Pleistocene, U.S.N.M. 13686, 13 vertebrae.

The only previously known fossil timber rattlesnake was the *C. horridus* discussed by Hay (1920) from Cavetown, Maryland. The material

from Massachusetts will be discussed by Hecht (MS), though I have examined the material and approve its identification as *C. horridus.* All the fossil material falls within the variation demonstrated by *C. horridus.*

Crotalus cf. lepidus Kennicott

Arizona, San Pedro Valley, Cochise County, Early Pleistocene. C.I.T. (no number), 1 vertebra.

The one small vertebra from the Pliocene of Arizona is probably *C. lepidus,* as it agrees with it in all characters. The fossil is so fragmentary, however, that it can only tentatively be referred to this species.

Crotalus mitchelli (Cope)

Nevada, Gypsum Cave, Late Pleistocene-Recent (8,000-10,000 years), C.I.T. (no number), 55 vertebrae plus one entire skeleton.

Crotalus potterensis Brattstrom

California, Shasta County, Potter Creek Cave, Late Pleistocene, U.C. 3129, 2 vertebrae, a part of a pterygoid, fragments of ribs and three other fragments of bones.

No other material has come to light since the recent original description of this extinct species.

Crotalus scutulatus (Kennicott)

Mexico, Zumpango, México, Pleistocene. C.I.T. Locality 310, C.I.T. (no number), 2 vertebrae.

These two mid-thoracic vertebrae do not differ from recent specimens of this species.

Crotalus viridis (Rafinesque)

California, Rancho La Brea, Los Angeles County, Late Pleistocene, L.A.C.M. Pits A, B, 81, U.C. locality 2052, many vertebrae.

California, McKittrick Asphalt, Kern County, Late Pleistocene, U.C. 35114, 35122, 35123, 35124, 35125, 35126, 35127, 35128, 20 vertebrae.

California, Hawver Cave, El Dorado County, Late Pleistocene. U.C. (no number), 5 vertebrae.

Iowa, Andrews Stone Quarry, above Sioux City, Pleistocene. U.S.N.M. 13655, 7 vertebrae.

Nebraska, Driftwood Creek, Hitchcock County, ?Lower Pliocene. A.M.N.H. 1639, many vertebrae, 2 fangs (length 7.0 and 6.8 mm. long), A.M.N.H. 1638, 2 vertebrae, A.M.N.H. 1637, many vertebrae.

Nevada, Gypsum Cave, Late Pleistocene-Recent (8,000-10,000 years). C.I.T. (no number), 17 vertebrae.

The California material of this widespread rattlesnake has been discussed (Brattstrom, 1953a, 1953b) as was the Gypsum Cave fossils (1954). As comparative measurements of *C. viridis* were given previously, the summary of the measurements made on the Gypsum Cave, Nebraska, and Iowa material is presented herein (Table I). The material from all three of these sites averages slightly larger than those from Rancho La Brea, though the maximum measurements are not larger than for the La Brea material.

AGE (12BBCAPS)

In the following list the North American Crotalids are listed by the age from which they have been recorded. An asterisk indicates that the species or subspecies is extinct.

PLIOCENE

Agkistrodon contortrix
Crotalus viridis

PLEISTOCENE

Agkistrodon piscivorus
**Crotalus adamanteus pleistoflordensis*
Crotalus atrox
**Crotalus giganteus*
Crotalus horridus
Crotalus cf. lepidus
Crotalus mitchelli
**Crotalus potterensis*
**Crotalus scutulatus*
Crotalus viridis

LOCALITIES

In the following list the North American Crotalids are listed as to the fossil localities from which they have been found.

ARIZONA

San Pedro Valley, Early Pleistocene
Crotalus cf. *lepidus*

ARKANSAS

Conard Fissure, Pleistocene
Crotalus horridus

CALIFORNIA

Rancho La Brea, Late Pleistocene
Crotalus viridis
Hawver Cave, Late Pleistocene
Crotalus viridis
McKittrick Asphalt, Late Pleistocene
Crotalus viridis
Potter Creek Cave, Late Pleistocene
Crotalus potterensis

FLORIDA

"Allen Cave," Lecanto, Pleistocene
Crotalus giganteus
Crotalus adamanteus pleistofloridensis
Melbourne, Late Pleistocene
Agkistrodon piscivorus
Crotalus adamanteus pleistofloridensis
Vero Beach, Late Pleistocene
Crotalus adamanteus pleistofloridensis
Seminole, Late Pleistocene
Agkistrodon piscivorus
Crotalus adamanteus pleistofloridensis
Crystal Springs, Late Pleistocene
Agkistrodon piscivorus
No Locality, Pleistocene
Crotalus adamanteus pleistofloridensis

GEORGIA

Cartersville, Pleistocene
Crotalus horridus

IOWA

Andrews Strong Quarry, Sioux City, Pleistocene
Crotalus viridis

MARYLAND

Cavetown, Pleistocene
Crotalus horridus
Cumberland Cave, Pleistocene
Crotalus horridus

MASSACHUSETTS

————, Pleistocene, Hecht, MS.
Crotalus horridus

NEBRASKA

Driftwood Creek, ?Lower Pliocene
Agkistrodon contortrix
Crotalus viridis

NEVADA

Gypsum Cave, Late Pleistocene-Recent
Crotalus atrox
Crotalus mitchelli
Crotalus viridis

PENNSYLVANIA

Carlisle Cave, Pleistocene-Recent
Crotalus horridus

TENNESSEE

Big Pigeon River, Pleistocene
Crotalus horridus

TEXAS

Bulverde, Pleistocene
Crotalus atrox

MEXICO

Zumpango, Pleistocene
Crotalus scutulatus

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Table 1

SUMMARY OF MEASUREMENTS (IN TENTHS OF MM.)
OF FOSSIL *Crotalus viridis*

Measurement	Locality Number of specimens, range (in parentheses), and average of measurements		
	IOWA	NEBRASKA	NEVADA
VERTEBRAE			
Height	1(138)	4(70-113)97	2(79-113)96
Width	7(45-54)49	12(33-63)49	2(49-74)62
Length at centrum	7(60)60	12(40-64)53	2(55-62)59
NEURAL SPINE			
Height	3(30-49)41	7(19-41)30	2(19-28)24
Width	3(38-47)56	7(24-47)38	2(43-46)45
PREZYGAPOPHYSES			
Width across	5(85-98)91	10(58-117)80	2(87-126)107
Width of process	1(20)	7(10-20)17	2(20-23)22
POSTZYGAPOPHYSES			
Width across	4(84-87)85	12(63-106)81	2(88-119)104
Width of process	1(20)	7(10-22)18	1(20)
CENTRUM			
Height	6(27-32)30	8(20-33)29	1(30)
Width	6(28-32)30	8(21-34)30	1(33)
ZYGOSPHENE			
Width across	5(37-40)39	7(27-48)41	1(50)
Height from centrum	5(25-30)28	7(19-30)28	1(29)
Width of process	5(10-20)20	7(10-21)18	1(20)

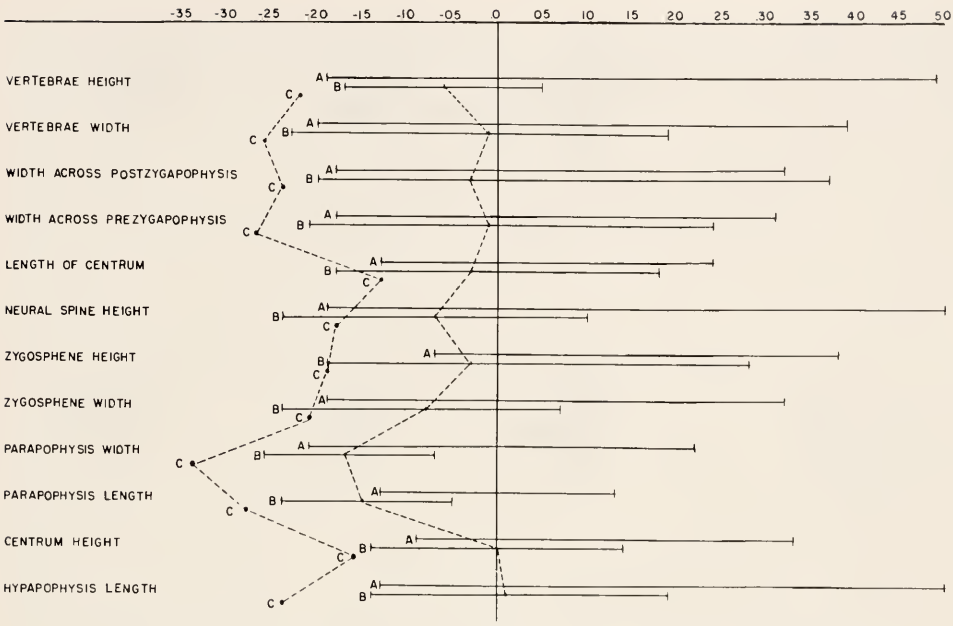

FIGURE 1. Ratio diagram (on a log-difference scale) showing comparison of certain osteological characters in *Crotalus giganteus* and two subspecies of *C. adamanteus*. A. Recent *C. a. adamanteus*, summary of many specimens. Standard (.0) is largest vertebra of a good-sized *C. a. adamanteus*, U.S.N.M. 29419. B. All Pleistocene material of *C. a. pleistofloridensis*; dashed line passes through average. C. Type of *C. giganteus*. A strong overlap is evident in A and B, with very little in C.

FIGURE 2. Thoracic vertebrae of *Crotalus adamanteus pleistofloridensis* and *C. giganteus*. 1 and 4, type and paratype of *C. a. pleistofloridensis*, Seminole, Florida. 5, 7, 8, 10, and 11, *C. a. pleistofloridensis*, part of syntypic series, Seminole, Florida. 6, 9, and 12, *C. a. pleistofloridensis*, A.M.N.H. 7514, Florida, no other data. 2 and 3, type and paratype of *C. giganteus*.

TRANSACTIONS

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ANALYSIS OF THE HERPETOFAUNA OF BAJA CALIFORNIA, MEXICO

BY

CHARLES H. LOWE, JR. and KENNETH S. NORRIS

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ANALYSIS OF THE HERPETOFAUNA OF BAJA CALIFORNIA, MEXICO

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I. INTRODUCTION

This study is the first of a series concerning the biogeography and systematics of the herpetofauna of Baja California, Mexico, and adjacent islands. Field work in this connection was begun at the close of World War II. In the summer of 1949, studies in Baja California were extended to the Cape San Lucas region, from sea level to the 7,000 foot crest of the Sierra Laguna. At this writing, work is continuing, both in the laboratory and field.

The patterns of ecologic and geographic distribution shown by the reptiles and amphibians of Baja California and adjacent regions can be correlated with the recently defined history of Tertiary environments of Western North America. This environmental history has been illuminated largely through advances in the field of paleobotany during the last decade. We propose to define the variation and ecologic distribution of the amphibians and reptiles of the peninsula and adjacent islands as well as available material well permit and to attempt the correlation of distribution patterns with the environmental history.

Among the new forms which have come to light in the course of our field work is a new northern coastal subspecies of *Crotalus enyo*, the Baja California Rattlesnake. This form is described, its ecology discussed, and pertinent new scale terminology is proposed.

II. ANALYSIS OF SUBSPECIFIC DIFFERENTIATION IN CROTALUS ENYO, THE BAJA CALIFORNIA RATTLESNAKE

SCALE TERMINOLOGY

There is, as yet, no adequate terminology for the somewhat irregular scales on the side of the head of *Crotalus*. *C. enyo* is not unique in having small scales present in three areas on the side of the head: (1) bordering the upper loreal, (2) at the upper anterior corner of the eye, and (3) about the loreal pit. Current problems relative to these scales have been obscured by the lack of an accepted precise terminology. This problem has been discussed with Laurence M. Klauber, and the new names for scales as used herein are the result of our mutual agreements (see Klauber, 1952:9, footnote).

Fig. 1. Distribution of the subspecies of *Crotalus enyo,* the Baja California Rattlesnake.

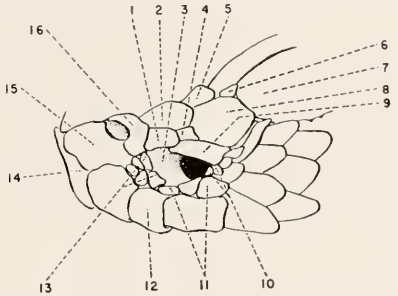

Fig. 2. Scales on the anterior lateral surface of the head of *Crotalus*, as exemplified by *C. enyo*. 1, lower loreal (subloreal); 2, upper loreal (supraloreal); 3, lacunal; 4, postloreal; 5, postsupraloreal; 6, preciliary; 7, orbit; 8, upper preocular; 9, lower preocular; 10, postfoveals; 11, subfoveals; 12, second supralabial; 13, prefoveals, (there are five in this example, as usual, they occupy a triangular area); 14, rostral; 15, prenasal; 16, postnasal.

The following terms for head scalation are suggested (see Fig. 2):

(1) *prefoveal(s)*, *subfoveal(s)*, and *postfoveal(s)*, for the small scales at the anterior, lower, and posterior borders of the pit. The scales lining the pit (and small extensions of these scales along its outer border) are termed *lacunals* (see below). Two of these terms (subfoveal and postfoveal) are restricted in the sense that they apply only to *the border row of scales about the pit* (Fig. 2). The prefoveals comprise all small scales in the small area anterior to the subfoveals which are bordered by the following scales: supralabial(s), subfoveal, lacunal, loreal or lower loreal, and nasal. Where prefoveals and subfoveals are to be distinguished on the one hand, and postfoveals and subfoveals on the other, is a matter of reference to a line drawn at 45 degrees to the horizontal, through the center of the pit. This is analogous to the situation in segregating suboculars and postoculars. The term prefoveal may prove to be the most useful of the three; the terms subfoveal and postfoveal may be used where they clarify description, as in *C. enyo*.

(2) *lacunal(s)*, for the relatively large scale(s) forming the inner border of the pit. These scales are reduced in size when foveal scales, particularly subfoveals, are present.

(3) *preciliary(s)*, for the small scale in the upper anterior corner of the eye. This scale is just below the contact of the postsupraloreal and the supraocular and is a derivative from the upper preocular scale, that is split off of its upper posterior corner. It is not consistently present in *C. enyo*. The postsupraloreal is more consistently present.

(4) *presupraloreal(s)* and *postsupraloreal(s)*, for the small scales which may border the supraloreal and which are, for the most part, below the canthus. Such distinction is useful in some species, including *C. enyo*, but becomes arbitrary and confusing in others, such as *C. molossus*, that have numerous scales in the loreal region. The *presupraloreal(s)* is anterior to the upper loreal (=supraloreal), between that scale and the postnasal. The *postsupraloreal(s)* is located posterior to the upper loreal, between it and the supraocular; it is anterior to, and slightly above, the preciliary, when that scale is developed. These scales are present in a few

species including *C. enyo* which characteristically has a single postsupraloreal but lacks a presupraloreal.

(5) *postloreal(s),* for the small irregularly occurring scale(s) interposed between the loreal(s) and preocular(s), as in *C. enyo.* By use of the proposed terms "postloreal" and "preciliary" in forms like *C. enyo,* there is no disturbance of the usual nomenclatorial designations of the regular upper and lower preoculars and upper and lower loreals. This distinction also is less applicable to forms, like *C. molossus,* that have numerous loreals.

Crotalus enyo furvus, subsp. nov.[1]

Dusky Baja California Rattlesnake

Holotype.—Adult male, No. 55388, Museum of Vertebrate Zoology, collected alive by Kenneth S. Norris and Charles H. Lowe, Jr., July 21, 1949, 10.9 miles (by road) north of El Rosario, along the main road on the coastwise terrace near the foot of a bold Cretaceous escarpment, Baja California Norte, Mexico. The type is deposited in the Museum of Vertebrate Zoology, University of California, Berkeley, California. (Fig. 3).

Diagnosis.—A distinctive subspecies distinguished from the pallid *C. e. enyo* by a very dark brown ground color and darker blotches and spotting; proximal rattle segment black; 10-12 (11.0) posterior body crossbands; the lacunal(s) wholly or partly separated, by 1-3 subfoveals, from the supralabial row; 3 scales (average) in minimum count between orbit and supralabials.

Measurements (taken on the fresh specimen) and scalation of holotype.—Snout-vent length, 606 mm.; tail length, 60 mm.; ratio of tail to total length, .090; head length, 30.6 mm., contained 21.8 times in overall length; head width, 21.7 mm.; ratio of head length to head width, 1.41.

Scale rows, 25-25-21, with 11 at middle of tail; scales are strongly keeled, with first and occasionally second rows smooth on anterior and middle body, with all rows keeled an extreme posterior body and tail. Ventrals, 162; subcaudals, 29, of which the last 4 are divided. Anal entire. Supralabials, 13—13; infralabials, 13—14. First infralabials undivided; first two in contact with genials on either side; mental triangular; neither intergenials nor submentals present. Rostral wider than high and in contact with supralabials. Internasals, 2. Minimum scale rows between supraoculars, 5. Nasals, 2–2. Loreals, 2, of approximately the same size, or larger than, upper. A postsupraloreal scale between supraocular and supraloreal. A single postloreal scale. Canthals, 3. Preoculars, 2, with suprapreocular larger. A preciliary scale in the upper anterior corner of eye. Minimum scale rows from supralabials to orbit, 3. Total scales in orbit, 9. Prefoveals, 6-4, subfoveals, 3-3, and postfoveals, 2-2, forming a complete row separating the supralabials from the lacunal on the outer margin of the pit floor. Rattle with 14 segments, broken near former tip.

[1] The name (*L. furvus,* dark) refers to the dark or dusky coloration of this race.

Coloration of holotype (in life).—The principal ground color of the upper surfaces is dark brown (Pl. 15, near C 6)[2] on the middle third of the body. Anteriorly, the ground color is slightly darker. Posteriorly, the ground color gradually lightens to tan (14, H 8) just anterior to the vent. Everywhere the ground color is somewhat darker than the primary dorsal row, or series, of blotches, which are rich brown (15, A 12) and are edged with black. The blotch outlines do not adhere to scale rows. The black-edging scales and black scales elsewhere are often tipped with gray (29, A 1). The dorsal blotches of the primary series gradually change backward from longitudinal rectangles on the neck through hexagons and crude diamonds to crossbands on the posterior body and tail. Dorsally, the brownish posterior body crossbands (15, L 12) are faintly edged with dark brown to black; laterally, they are darker brown (15, A 17). A secondary series of smaller blotches, on the lower lateral surface, parallels the primary series. These are variously positioned on the first six scale rows. On the posterior body, they coalesce with the dorsal series to form the afore-mentioned crossbands. Anteriorly, however, they are well separated from the dorsal blotches; the first 5 or 6 on the neck are brown, bordered with black as in the dorsal primary series. Farther back, they take the form of small black spots, involving 2 to 5 scales, until they coalesce with the primary series where they are brown. Still smaller and lighter spots on the first 3 scale rows form a tertiary series and alternate with the elements of the secondary series. They vary in color from black to brown (anterioposteriorly). Faint traces of other blotches, appearing as slight darkenings of the ground color, occur above the tertiary spots on the mid-lateral surfaces, alternate with the spots of the primary and secondary series. These faint blotches in the adult may be traces of more prominent juvenile markings which fade in ontogeny.

The ground color of the upper surfaces of the head posterior to the eyes is the same as that of the neck and anterior body. On the anterior portions, the ground color is an even darker brown. A pair of parallel longitudinal marks begins at the dark brown (8, J 10) supraoculars and continues posteriorly onto the neck, where they become confluent just anterior to the first dorsal blotch. They do not join with this blotch. The brown color (15, A 1) and black bordering of these marks is approximately the same as that of the dorsal blotches. A darker lateral head stripe of rich olive brown (15, H 7), stippled with blackish brown and faintly bordered with black, arises at the ventroposterior corner of the eye, passes backward above the commissure and turns below it posteriorly. No preocular light line is present. A light tan (12, C 5) supraocular cross mark on the anterior half of this scale widens mesially, curving both forward and inward from the outer edge.

The color and pattern of the proximal two-thirds of the tail approximates that of the extreme posterior body. There are 5 light brown crossbands on the tail. The distal third of the tail is a uniform dark blackish brown. The proximal rattle segment is solid black; the second segment

[2] Maerz and Paul (1930) color determinations.

is black tinged slightly with brown. The remaining segments are light brown.

Ventral coloration at mid-body is yellowish (10, C 2 to 10, E 2), with light brown stippling, becoming lighter anteriorly and evenly grading to white on the neck and ventral surface of the head. The mental and first 4 infralabials are a darker blackish brown than the remaining infralabials. The genials and other ventral scales of the anterior portion of the head scales are stippled with light brown over the white ground color. Occasional brown stippling occurs on the remainder of the gular area. The color of the iris is light brown (13, C 5).

Intrasubspecific and *intersubspecific variation.*—Individual differences are slight in the 4 available specimens of *C. e. furvus.* Certain of these differences are set forth in Table 1, in which comparison is also made with *C. e. enyo.* The largest specimen of *furvus,* a badly damaged male DOR (KSN 1337), measures approximately 580 mm. from snout to vent.

Like many other immature rattlesnakes, a female of *e. furvus* (LMK 41087), studied shortly after preservation in alcohol, was found to be lighter in ground color and bolder in pattern. The mediolateral blotches that alternate with those of the primary and secondary series are clearly marked and less obscured than in the adult. These marks are absent from the neck and posterior quarter of the body in the immature. In color they are darker brown than the ground color and partly edged with black in the same manner as the dorsal primary series of blotches. In this small specimen there are two prominent black spots on each infralabial row; one is on the third infralabial scale, and the other, of approximately the same size, borders the ninth and tenth infralabials. The dorsal head marks of this specimen are unlike the type and more like *e. enyo* in being broken at the middle of the head and not confluent posteriorly. In addition, this specimen does not have a preciliary scale, and in contrast to the remainder of the topotypic series, the upper and lower loreals are of approximately the same size on one side, but with the upper still slightly larger on the other side. Nevertheless, it appears that a difference in the size of the loreals may prove to be another diagnostic scale difference between *e. enyo* and *e. furvus.*

In *e. enyo,* the third and fourth supralabials are often in contact with the lacunal scale. In *e. furvus,* the supralabials are completely or nearly completely separated from the lacunal(s) by one or more small foveals (see Fig. 2). Many of these small scales (particularly the subfoveals), when present, are developed at the expense of the material which would otherwise form a larger lacunal scale(s).

When a larger series of *e. furvus* is available, the following characters may prove to be clinal: the number and relative size of canthals, relative size of the upper and lower loreals, number of scales between supralabials and orbit, number of scales in orbit, number of prefoveals and subfoveals, and number of infralabials in contact with genials. The geographic differences in color (Table 2) may intergrade sharply, in step-cline fashion. The color features of both *e. furvus* and *e. enyo* appear

to be correlated with color features of their habitats. The known ranges of the subspecies of *C. enyo* (Fig. 1) are separated by about 60 miles and no intergrades have yet been taken. The northernmost specimens of *e. enyo* were collected by L. M. Huey in 1930 from Jaraguay and from near Cataviña (Klauber, 1931). These two northerly specimens of *e. enyo* extended the known range of the species about 270 miles north of the northernmost previously known record, at Mulegé. The type specimen of *e. furvus*, collected near El Rosario in 1949, again extended the known range of the species an additional jump to the north—in this case 60 miles, nearly 20 years later and in a relatively well traversed area of Baja California. The third specimen of *e. furvus*, from Punta Camalú, extended the range northward an additional 45 miles; the fourth specimen slightly farther. With additional collecting, the present gaps will almost certainly narrow, and intergrades between the two subspecies may be expected. The new form is accorded subspecific status because the discovery of intergradation is anticipated and because, even though geographic intergrades are not discovered or do not exist, the differences will not prove sufficiently consistent to warrant specific separation. The differences, furthermore, appear to represent the low level of morphological difference usually associated with subspecific differentiation.

Locality Records.—In addition to the type, 3 specimens (paratypes) of *C. e. furvus* are available. These are (1) an immature female, LMK 41087, collected (LOR) by Charles E. Shaw and Richard Schwenkmeyer, April 2, 1950, 2 miles north of El Rosario, near the type locality; (2) an adult male, KSN 1337, collected (DOR) by Kenneth S. Norris, August 30, 1951, at Punta Camalú; and (3) an immature female, KSN 1454, collected (DOR) by K. S. Norris and Arthur Lockley, May 24, 1952, 9.5 miles south of San Telmo River valley (on main road), all in Baja California Norte, Mexico.

The localities at which *C. enyo* has been collected are the following:[3]

CROTALUS ENYO ENYO

Southern Cape Region, Baja California, Mexico
- Cape San Lucas (type locality)
- La Paz
- San José del Cabo
- San Bartolo
- Miraflores
- 6 miles south of Miraflores
- Santa Anita
- San Antonio
- Sierra de la Laguna, opposite Todos Santos
- San Pedro
- Todos Santos
- Sierra de la Laguna
- La Rivera
- Eureka
- San Pedro Mountains

[3] Localities are from published data (Klauber, 1931; Gloyd, 1940), from Klauber (*in litt.*), and localities recorded during our studies to date.

Central Baja California Region
Mulegé
San Ignacio
29 miles south of Punta Prieta
Almejas Bay, Santa Margarita Island
Los Angeles Bay
10 miles west of Los Angeles Bay
2 miles south of Los Angeles Corral
1.6 miles west of San Ignacio

Northern Baja California Region
Jaraguay
10 miles north of Cataviña

Gulf of California Islands
Isla Partida
San Francisco Island
Carmen Island

CROTALUS ENYO FURVUS

Northern Baja California Region
10.9 miles north of El Rosario, along main road (type locality)
2 miles north of El Rosario, along main road
Punta Camalú
9.5 miles south of San Telmo River valley, along main road

Ecology and Distribution.—The area from which the four specimens of *C. enyo furvus* have been taken is relatively limited in extent. This is the coastal strip from 2 miles north of El Rosario northward to Punta Camalú, 65 miles north of El Rosario. Almost certainly this does not represent the total range of the animal. The plant associations and climatic conditions typical of the localities at which the snake has been found to date extend both north and south of the present known localities. A tentative and conservative estimate of the probable range of the subspecies, the evidence for which is discussed below, is the western coastal area of northern Baja California from Punta San Antonio (or possibly Punta Canoas farther to the south) northward to Cabo Colnett. This range includes the townsites of El Rosario and San Quintín.

At San Quintín, in 1949 and prior to the finding of the Camalú (northernmost) specimen, the authors and Mrs. Lowe were the guests of Mr. Frank Frymier, a resident American farming on the flat plain. He described two kinds of rattlesnakes from the plain, a large red one (obviously *C. r. ruber)* and a smaller "gray" one *(C. enyo furvus)*. Both were adequately described from his firsthand knowledge of the snakes. (The Camalú and near San Telmo River valley specimens, more recently collected, confirm our opinion that *C. enyo furvus* is an inhabitant of the San Quintín area and northward.) Mr. Frymier said that many of the small gray rattlesnakes were killed during brush clearing operations. A large drag was pulled over the brush, rolling it away from the ground. He stated the red snake and the smaller "gray" one were present in about

equal numbers. When shown living *C. r. ruber* and *C. enyo furvus*, he identified them as being the two rattlesnakes present on the plain.

The San Quintín Plain extends for several miles along the coast. Beyond the plain to the north, to a few miles north of Punta Cabras which is north of Cabo Colnett, and to the south at least to Punta San Antonio (south of El Rosario), there is a continuation of the same open, low-growing scrubby vegetation on the coastly terraces. South of El Rosario, the coast rises more abruptly to foothills than it does to the north. Similarly, north of Punta Cabras the country is rugged and mountainous along the coast, with narrow coastal shelves and numerous high sea cliffs. Rather marked environmental changes occur over relatively short distances to the northward, eastward, and southward of the coastal area just described. *C. e. furvus* may also occur on the higher coastal terraces back of the San Quintín Plain.

At the type locality (Fig. 3B), 10.9 miles north of Rosario (along the main road), which is south and slightly higher in elevation than the San Quintín Plain, the habitat is a marine terrace extending inland from sea bluffs to nearby low hills. The area is covered by low shrubby vegetation. *Euphorbia misera* is a conspicuous plant. It is common both to the north and south along the coastal plains and terraces. *Agave* and *Opuntia* are conspicuous but less common.

It is of interest to note that the extreme latitudinal range of the endemic *Crotalus enyo* from Cape San Lucas northward is nearly within that of the giant cactus, *Cereus pringlei*, the "Cardón" or "Cardón Grande." The northernmost Cardóns occur in the vicinity of Hamilton Ranch and on the San Quintín Plain. Another conspicuous cactus, the Senita (*Cereus schottii*), reaches its northern limit in Baja California in this general vicinity.

At San Quintín, average rainfall is approximately 5 inches annually, and increases northward to approximately 9 inches at Ensenada (Beal, 1948). Southward, rainfall decreases rapidly, though coastal fogs are of common occurrence on the Vizcaíno Desert and farther south. The terraces and plains in the general vicinity of San Quintín and El Rosario are areas characterized by a markedly more mesic climate and biota than the harsh environments both southward and in the interior.

As has been pointed out, the manner in which the two subspecies of *C. enyo* differ most conspicuously is in the degree of difference in amount of melanin. *C. enyo enyo* is light colored, and *C. enyo furvus* is dark colored. The darker form occurs on darker soils and in an environment of higher moisture levels and less extreme diurnal and seasonal temperature fluctuation. All these factors are in contrast with those in the habitat of *C. enyo enyo*.

Little has been recorded of the behavior of *C. enyo*. Klauber (1931) states: "Both island specimens (San Francisco and Carmen Islands) contained mammal remains, and observations on captive specimens and character of the eye are indicative of largely nocturnal habits. A specimen 608 mm. in length collected March 22, contained eggs."

The type was captured by tracking it at noonday to the mouth of a small rodent burrow where the snake was found resting with part of its

coils in the sunlight. When first observed, it remained motionless and did not rattle. It blended perfectly with the dark soil background and would not have been seen at all had not its track betrayed its presence. The snake was not extremely vicious, nor was it as docile as are most individuals of *C. r. ruber* upon capture.

A specimen of *C. enyo enyo,* captured alive 1.6 miles west of San Ignacio, was very difficult to see lying across the rocky road. Its light background color, matching effectively, concealed the animal. When this specimen was shown to Mexicans at San Ignacio, they told us it was most commonly found in rocky areas. *C. enyo,* in this more southerly area, appears to occupy a markedly different microenvironment than does *C. e. furvus* to the north. On June 21, 1949, at dusk, the following temperatures were recorded for the adult specimen from near San Ignacio: cloacal temperature, 29.7°C.; air temperature (1 cm. above the ground), 27.5°C.; soil surface, 32.1°C.

Acknowledgments

Our studies of the herpetofauna of Baja California have been greatly facilitated by Mr. C. M. Goethe of Sacramento, California, Mr. Joseph R. Slevin of the California Academy of Sciences, Dr. Laurence M. Klauber of the San Diego Society of Natural History, and Drs. Raymond B. Cowles and the late Adriaan J. van Rossem of the University of California, Los Angeles. We are especially indebted to Dr. Cowles and Mr. Goethe for assistance in our field work conducted in Baja California during 1949, during which time *Crotalus enyo furvus* was first found.

Drs. Howard K. Gloyd, Laurence M. Klauber, and Carl L. Hubbs have read manuscript and gave many helpful suggestions that have been incorporated. Fig. 2 was drawn by Mr. Donald B. Sayner of the University of Arizona.

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Table 1

Intrasubspecific and Intersubspecific Variation in *Crotalus enyo*

Subspecies	*furvus*				*enyo*
	ad. ♂ Type MVZ 55388	ad. ♂ KSN 1337	imm. ♀ KSN 1454	imm. ♀ LMK 41087	Klauber (1931)
Snout-vent length, mm.	606	643	410	457	.....
Total length, mm.	666	711	436	486	.....
Tail length, mm.	60	68	26	29	.....
Head length, mm.	30.6	31.0	23.4	25.2	.....
Head width, mm.	21.7	.....	17.6	17.6	.....
Ratio, tail length to total length	.090	.096	.060	.060	Ave. .090(♂), .065(♀)
Ratio, total length to head length	21.8	22.9	16.3	19.3	22.5 - 25.8(23.8)
Ratio, head length to head width	1.41	.....	1.89	1.43	Ave., 1.52
Ground color	dark (browns)	dark (browns)	dark (browns)	dark (browns)	light (grays)
Percentage of specimens having paired dorsal head marks engaging first dorsal blotch	0	0	0	0	ca. 50
Body blotches	37	36	42	42	30 - 42
Crossbands on posterior body	10	10	12	12	9*, 7*
Crossbands on tail	5	6	5	4	♂, 5-8(6.2) ♀, 4-5(4.3)
Scale rows at mid-body	25	25	25	25	25
Ventrals	162	inj.	170	171	♀, 165-177(170) ♂, 160-167(164)
Subcaudals	29	27	18	20	♀, 18-22(19.3) ♂, 22-28(25.1)
Supralabials	13-13	13-13	14-13	14-14	12-15(13.4)

TABLE 1 (Continued)

Infralabials	13-14	14-14	14-15	14-14	12-15(13.6)
Infralabials in contact with genials on either side	2	3	2	3	3, rarely 2
Internasals	2	2	2	2	2
Canthals	3	3	2	3	1-3 (2)
Minimum scale rows between supraoculars	5	6	5	4	2-6 (4.2)
Upper loreal larger than or approximately same size as lower	Yes	Yes	Yes	Yes, one side only	larger, 1 equal, 4 smaller, 22
Preciliary	Present	Present	Absent	Absent	Usually absent
Total scales in orbit	9	10	8	8	Ave., 9.7
Prefoveals	6-4	-5	5-6	7-7	5-5* 5-5*
Subfoveals	3-3	-3	1-1	2-3	0-0* 0-0*
Minimum scales, supralabials to orbit	3	3	3	3	2-3(2.1)

Data on *C. e. enyo* as given by Klauber (1931), except as indicated by asterisks; asterisks indicate characters for which data are not given by Klauber, but supplied by us for two specimens of *C. e. enyo* from vicinity San Ignacio and vicinity La Paz, respectively. KSN 1337 (male) is a damaged specimen (DOR), making certain accurate measurements and counts unobtainable. Abbreviations are as follows: MVZ, Museum of Vertebrate Zoology, University of California, Berkeley, California; LMK, Collection of Laurence M. Klauber, San Diego, California; KSN, Kenneth S. Norris, field catalogue, specimens deposited in the Lowe-Norris Baja California, Mexico, collection.

Table 2

Colors of Representative Specimens of the Subspecies of *Crotalus enyo*

Recorded on live specimens in the field, in June and July, 1949, according to our notations by Maerz and Paul (1930).	*furvus* Type, ad. ♂ SV, 606 mm.	*enyo* San Ignacio, ad. ♂ SV, 553 mm.
Ground color of upper surfaces, middle body third	brown (near 15, C 6)	gray (12, A 1) and pink (9, C 6)
Ground color of upper surfaces, posterior tail third	blackish brown	grayish green (14, J 4)
Ground color at mid-venter	darker yellow (10, C 2 to E 2)	lighter yellow (9, D 1)
Color of mid-dorsal blotch centers	darker brown (15, A 12)	lighter brown (14, K 7)
Color of lateral head stripe	olive brown (15, H 7)	brown (15, C 5)
Color on mental, infralabials, and genials	brown to blackish brown	white to light gray
Color of iris	light brown (13, C 5)	grayish pink (6, B 7)
Color of proximal rattle segment	black	blackish brown, streaked with grayish green

Plate 4. Type specimen of *Crotalus enyo furvus*.

Plate 5. Type locality of *C. e. furvus*, 10.9 miles north of El Rosario, along main road, Baja California Norte, Mexico. From low coastal terrace, looking inland toward escarpment of higher terrace, with eroding ledges of Cretaceous bed.

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SNAKES OF THE ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

BY

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In connection with a general study of the herpetofauna and zoogeography of the islands in the Gulf of California, several new species and unrecorded occurrences of snakes have come to light. As an aid to other workers, it seems advisable to present the new data in advance of the larger work, and to integrate these data in a revised synopsis of the snakes of the islands.

Much new material has been collected on the islands and deposited in the Stanford Natural History Museum through the generosity of Mr. Joseph W. Sefton, Jr., and the Sefton Foundation of San Diego, California. The Foundation's fine research ship *Orca* was made available to a group of biologists, primarily from Stanford University, for two successive spring trips in the Gulf. The 1952 trip lasted three months and the 1953 trip six weeks. Previous to the *Orca* expeditions, only two major expeditions had visited the islands, that of the United States Bureau of Fisheries Steamer *Albatross* in 1911 and that of the California Academy of Sciences expedition in 1921. Subsequent to these two expeditions, few specimens have been taken from the islands, largely the result of incidental collecting by persons engaged in other work.

Twenty-nine species and subspecies of snakes are now known to occur on the islands (see Table 1). Twelve of the 29 species and subspecies, or about 40 per cent, are endemic to single islands.

In studies of island populations, the question of what constitutes a species and what constitutes a subspecies is immediately raised. Obviously, there is no completely free exchange of genes or interbreeding between populations on the islands and the mainland, or between different islands. Inasmuch as no experimental work has been done, the only criterion for specific or subspecific recognition that can be used in these instances is the degree and constancy of morphological differences between populations. If the island population is widely different from that encountered on the mainland or adjacent islands and is consistent in these differences, the insular population is best termed a species. However, if the island population is only slightly different and its differential characteristics not entirely constant, it is best known as a subspecies.

The plant associations on the islands are quite similar to those found on the adjacent mainland. The flora of the islands has been indicated as only two per cent endemic (Johnston, 1924). Collecting on the islands is quite different from collecting on the mainland, because, on the islands, the reptiles occur in much greater densities. This is especially true of the lizards. The vegetation of most of the islands is denser than that of the mainland. This ecological factor may be the cause of the higher density of the reptile population.

More collecting on the islands will undoubtedly disclose new records and possibly new species of snakes. *Crotalus* and *Hypsiglena* probably occur on all of the larger islands. Burrowing and nocturnal snakes are also to be expected, especially representatives of the genera *Leptotyphlops,*

Lampropeltis, Chilomeniscus, and *Sonora.* It is strange that no *Pituophis* has been taken on any of the islands.

In the text and on the map (fig. 1), the islands are assigned the most generally accepted names. Two islands in the Gulf of California are called Partida. The southern Partida lies just to the north of Espíritu Santo Island and at low tide is separated from it by a water gap of only ten feet. These islands are a biological unit and are included in this report as such, under the name of the larger island, Espíritu Santo. The northern Partida (Partida del Norte) lies between Angel de la Guarda Island and Raza Island. San José Island is sometimes written as San Josef, but the former name is now generally accepted. Cerralvo Island appears as Ceralbo or Ceralvo on some maps, but the majority of modern maps now designate the island as Cerravlo.

The small islands north of San Luis Bay are named San Luis Island (or Islands) on many published charts and other maps, but locally, the name Isla San Luis is applied to the island in San Luis Gonzaga Bay, and that seems to be the correct usage. The islands north of the bay are variously named. The group as a whole is known locally as Islas Las Encantadas, though some persons recognize as a "correct name" Islas Salvatierra. The largest and southernmost, to which the name San Luis has been wrongly applied, is more properly known as Isla Encantada Grande. Just northwest is a much smaller islet, Isla Poma. Ten miles northwest of Encantada Grande lies Isla El Muerto, the only island on which snakes have been found. Between Encantada Grande and El Muerto are Isla Choyudo (or Cholludo) and Isla Coloradito. Northwest of El Muerto, and very close to the mainland shore, is the smallest island of the group, Isla Huérfanito. These names seem to be in universal local use, though they conflict with names applied on the few maps that assign any name other than San Luis to any of these islands. The conflicting names applied to these islands are discussed by Klauber (1949, p. 96). He lists, in addition to the islands mentioned here, an island between Encantada Grande and El Muerto. Dr. Carl L. Hubbs, Scripps Institution of Oceanography, who has supplied data on the proper names of these islands, informs me that there is no island between La Encantada and Pomo and consequently there are only six islands in the group, rather than seven as listed by Klauber.

Abbreviations have been used to designate the museums where specimens are deposited, as follows: SU, Natural History Museum, Stanford University; CAS, California Academy of Sciences; LMK, private collection of L. M. Klauber; MVZ, Museum of Vertebrate Zoology at the University of California, Berkeley; MCZ, Museum of Comparative Zoology at Harvard University; USNM, United States National Museum.

Lichanura roseofusca gracia Klauber, 1931

A single dried example of this subspecies is known from Mejía Island. This single example (CAS 50804) was found under a rock by J. R. Slevin on June 28, 1921.

Scale counts are impossible to make with certainty because of the dried and brittle condition of the specimen. Ventral and caudal counts are likewise impossible to ascertain, since the snake is broken into several pieces and portions are missing. I am assigning this specimen to the subspecies *gracia* because the longitudinal stripe is present, it has even edges, and it is red brown. On geographical grounds, also, this subspecies

would be expected on a northern island, as it occurs on the adjacent mainland of Baja California.

Chilomeniscus cinctus Cope, 1861

A single male (SU 14035) referable to this species was collected on San José Island near Punta Salina on April 11, 1952. It constitutes a new insular record.

It is a young specimen only 152 mm. from snout to vent, tail length 27 mm. Ventrals number 109, caudals 25, supralabials 7, and infralabials 8.

The head scales are typical of mainland examples of the species and consist of: a rostral twice as wide as high, paired nasal-internasals which are separated medially by the posterior apex of the rostral, paired prefrontals which are in contact medially, and a shield-shaped frontal which is bordered by 2 parietals posteriorly. On either side there is 1 preocular, 2 postoculars and no loreal. The third and fourth supralabials contact the eye.

In coloration, this example is similar to the endemic species from Espíritu Santo Island, *Chilomeniscus punctatissimus*. The 32 brown bands are slightly wider than the interspaces. The interspaces contain a series of dots; these dots are about half a dorsal scale in size and are of the same color as the bands. The head scales anterior to the first body band are gray-olive and are suffused with light brown. None of the bands encircle the body; the majority barely touch the ventrals. Five of the bands are on the tail. However, in both squamation and coloration, this example falls well within the limits of variation for *C. cinctus*.

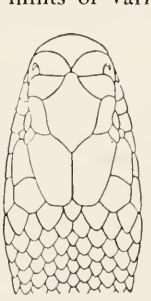

Figure 2. Outline Drawing of the Head of *Chilomeniscus savagei*. Holotype (SU 14034).

Holotype (SU 14034). Collected under debris on the sand dunes on the southwest coast of Cerralvo Island by Jay M. Savage, April 3, 1952. The snake is named for the collector whose numerous suggestions and thorough knowledge of the reptile and amphibian fauna of Baja California have aided me on numerous occasions.

Diagnosis: This distinctive insular species differs from all other species of the genus in having a higher number of ventrals and unique color pattern, and from all species except *C. punctatissimus* from Espíritu Santo (Partida portion), in having the prefrontal reduced in size and the frontal contacting the fused nasal-internasal.

Description of type: A mature female, 234 mm. in length from snout to anus, length of tail 34 mm., head length 10.3 mm., head width 6.0

mm., greatest width of body 8.0 mm., greatest eye diameter, 1.1 mm.

Head not distinct from body; short tail tapering to a point. The upper jaw protrudes and the rostral is prominent. The pupil is round. The scales are smooth, with no apical pits; they are arranged in 15–13–13 rows, with 6 scale rows at the middle of the tail length. The ventrals number 134 and the paired caudals 27. The anal plate is divided. There are 7–7 supralabials and 8–8 infralabials. The supralabials increase in size posteriorly; the last is the largest; the third and fourth contact the eye.

The rostral is about twice as wide as high and extends posteriorly to a blunt angle partly separating the nasal-internasal. The inferior surface of the rostral has a central depression near its posterior margin.

The scales on the crown comprise paired nasal-internasals, paired prefrontals, paired supraoculars, paired parietals, and a single median frontal. The nasal-internasals meet medially and meet the first supralabial, prefrontal, and rostral broadly; they barely touch the second supralabial. The valvular nostril is pierced near the lateral edge of the nasal-internasal. The prefrontals are widely separated medially by the forward extension of the frontal and also meet the preocular, supraocular, second supralabial, and nasal-internasal. The frontal is shield-shaped and is bordered posteriorly by the 2 large parietals. There are two postoculars, the upper of which is the larger. The temporals are 1–2. There is no loreal.

There are two pairs of chin shields. The anterior comes to a point medially, the posterior to a point laterally. The anterior is slightly larger. The first supralabial extends laterally to separate the mental completely from the chin shield. The anterior chin shield is bordered laterally by the first three infralabials. Four scales separate the posterior chin shields from the most anterior ventral.

Coloration: The very simple pattern consists of 29 body rings of a light brown color about 3 scale rows wide. The light interspaces are narrower, about 2 scale rows wide. The most anterior dark ring extends from the edge of the second preocular on each side to the posterior edge of the parietals. The posteriormost ring surrounds the end of the tail. The dark body rings are continued onto the ventral surface, where all but a few of the anterior merge into one another. Five of the rings are on the tail. In life, there is a pinkish-orange suffusion in the flesh-white interspaces, which includes the vertebral scale row in addition to from 2 to 3½ scales on each side. This suffusion is bleached out in preservative. The snout is white. In life, the venter between the brown rings is a delicate pink, but in the preserved state this color disappears and the venter is an immaculate flesh color. The throat is slightly suffused with brown. The rostral, nasal-internasal and anterior portions of the prefrontals and frontal are white in life, but turn yellowish in preservative.

The paratype (SU 16062) is an adult female with an incomplete tail, collected by John P. Figg-Hoblyn in the sand dunes near the place where the holotype was collected, on Cerralvo Island, but a year later, on March 20, 1953. The paratype has 136 ventrals, 7 supralabials, 8 infralabials and has the same details of head squamation as the type. It differs in that none of the body blotches encircle the body. Most, however, extend onto the ventrals. The first and only blotch on the tail completely encircles it.

Relationships: In color pattern, this insular species resembles *Chilomeniscus cinctus* from Arizona, Sonora, and the mid-peninsula region of Baja California. It shares its distinctive arrangement of head scales only with the species from Espíritu Santo Island. In addition, the Cerralvo specimens have a higher number of ventrals than any other species. It is problematical whether the two species on Cerralvo and Espíritu Santo islands are insular relics of an older stock of *Chilomeniscus,* or whether the evolution of these species has been effected solely through isolation in an insular environment. It does seem evident, however, that the two insular species are closely related and, since Cerralvo harbors many distinctive species, it would appear likely that Espíritu Santo Island has derived its species of *Chilomeniscus* from Cerralvo.

Chilomeniscus punctatissimus Van Denburgh and Slevin, 1921

This insular species, based on only one specimen from Partida, Espíritu Santo Island, was placed in the synonymy of *Chilomeniscus cinctus* by Smith (1945, p. 34). Inspection of the type and comparison with mainland and insular examples of the genus warrant the specific recognition of this single example.

The holotype of the species is CAS 49516, an adult female collected on Isla Partida by Chamberlin, May 31, 1921.

The most important characters separating this species from *C. cinctus* lie in the arrangement of the scales on top of the head. As in *Chilomeniscus savagei,* the prefrontals are reduced in size, allowing the frontal to meet the fused nasal-internasal. On each side, a small scale is interposed laterally to the prefrontal and above the first supraocular, which forms the posterior border of the nasal opening, but I believe this to be of very little taxonomic importance.

Van Denburgh and Slevin recognized this species primarily on the basis of the spotting that occurs on the light interspaces between the body blotches—a character of little importance in this genus, as pointed out by Linsdale (1932, p. 382).

A brief redescription of the species seems desirable, with particular emphasis on head squamation. The scales on the top of the head comprise paired nasal-internasals, prefrontals and supraoculars, a single rostral, and a frontal. The rostral is about twice as wide as high and extends far enough posteriorly almost to interrupt the contact of the internasals. The prefrontals are prevented from touching one another medially by the forward extension of the frontal, which extends anteriorly to meet the internasal. The small single preocular touches the small postnasal; there is no loreal. There are 2 postoculars. The supralabials number 7–7, the infralabials 8–8. The third and fourth supralabials border the eye. The dorsal body scales are in 13 rows; they are smooth with no apical pits. The anal plate is divided. There are 120 ventrals and 23 caudals.

Coloration: There are 39 dark brown bands on the body, including both the band on the head that extends from the anterior margin of the eye to the middle of the last supralabial and the dark tip of the tail. The interspaces are slightly wider than the bands. Within the light interspaces there are from 10 to 15 light tan spots which may occur on any of the dorsal scale rows except the 2 lateral rows on each side. The spots are

most intense near the vertebral scale row and are about half as large as the dorsal scales.

Relationships: As discussed under *C. savagei,* this species is considered to be closely related to the Cerralvo species and possibly derived from it.

Hypsiglena torquata gularis Tanner, 1954

The two females of this genus from Partida Island have recently been considered to represent a distinct insular subspecies. The type is CAS 51009, and the paratype 51010. Ventrals number 185–183, caudals 43–43, scale rows at midbody 17–19, and body blotches 68–68.

This subspecies is most closely related to *H. t. venusta* of the mid-peninsula, from which it is said to differ in having larger dorsal blotches, one or more pairs of enlarged gulars, fewer caudals, and a proportionately shorter tail.

Hypsiglena torquata ochrorhyncha Cope, 1860

This subspecies, which occurs in the Cape region of Baja California, is found on San José Island. Four specimens are known from this island: CAS 57398 and 57392, and LMK 3816 and 3815. The first three are males. Ventrals number 176–178–168–176,[1] caudals 46–50–50–47, scale rows at midbody 17–17–17–17 and body blotches 52–50–65–66.

This subspecies is distinguished from *H. t. venusta* in having fewer and correspondingly larger dorsal blotches and in having fewer ventral and caudal plates. The body blotches are undivided dorsally, and there is no median light stripe.

Examination of more specimens of this subspecies will probably lead to the distinguishing of a Cape subspecies from the populations in Arizona and Sonora. A trend is evident in ventral counts, but no characters that would justify nomenclatorial separation have as yet been discovered.

[1]Counts listed in same order as register numbers of the specimens.

Hypsiglena torquata tortugaensis W. Tanner, 1944

This subspecies is known from only two male specimens from Tortuga Island. The type is CAS 51460 and paratype LMK 4074.

The insular subspecies may be separated from the mainland forms, *ochrorhyncha* and *venusta,* by a higher number of ventrals and caudals, as shown in the following table:

	Male ventrals	Male caudals
ochrorhyncha	166–188	46–66
venusta	176–184	54–56
tortugaensis	187–190	57–59

The other distinguishing characteristics of this insular subspecies are an elongate narrow median stripe on the neck and divided lateral neck stripes.

Tanner (1944, p. 70) believes that this insular subspecies is more closely related to *venusta* than to *ochrorhyncha.*

Hypsiglena torquata venusta Mocquard, 1899

The mid-peninsula subspecies of *Hypsiglena* is known from the following Gulf of California islands: Carmen, San Marcos, San Esteban,

and San Francisco. The specimens from the last two islands constitute new insular records.

This subspecies is distinguished from *ochrorhyncha* in having a higher number of dorsal blotches, in having these blotches of small size, and in having the blotches alternating or divided to produce two rows instead of one, with a resultant light median dorsal stripe narrower than one scale in width.

The single female from San Esteban Island (SU 16066) has 179 ventrals, 29 caudals (tail incomplete), 21 scale rows at midbody, and 74 body blotches. On the posterior quarter of the body, the blotches coalesce.

The two females from San Francisco Island (SU 16067 and 14039) have 183–180 ventrals, 46–44 caudals, 21–21 scale rows at midbody, and 76–81 body blotches.

There are also two females from Carmen Island (CAS 51814, and MCZ 31583). The counts are as follows: ventrals 174–182, caudals 50–51, 19–19 scale rows at midbody, and 95–95 body blotches.

The male from San Marcos (CAS 51462) has 184 ventrals, 54 caudals, 19 scale rows at midbody, and 74 body blotches.

Lampropeltis catalinensis Van Denburgh and Slevin, 1921

This beautiful and distinctive insular species is known from a single adult male (CAS 50514) which was dug from the center of a decaying cactus stump on Santa Catalina Island. Although a thorough search for this species was made on both the occasions on which the author was on this island, no additional specimens were collected. A shed skin was found near a small spring which may have been from a *Lampropeltis*, but no live animals were seen or captured.

Since Van Denburgh (1922, p. 769) has presented a detailed account, only a short description will be presented here.

Ventrals number 228, divided caudals 63, scale rows at midbody 23, supralabials 8, infralabials 9. Color and color pattern are the distinguishing peculiarities. A purple longitudinal dorsal band, about 5 scale rows wide, extends from the head to the end of the tail. Along this mid-dorsal line, at intervals of 3 to 4 scales, are light yellow spots on a single scale. The lateral dorsal scales are purple with light yellow centers. The head above has the same color as the dorsal band and is marked with light yellow suffusions on the crown and sides. The ventrals and caudals are black, with extensive white marbling in an irregular pattern. The under surface of the head is light yellow, with the chin shields, gulars, and first several ventrals edged with black or purple.

The only other *Lampropeltis* with a color pattern near that of *catalinensis* is *L. nitida* from the Cape region of Baja California, which has a poorly defined light mid-dorsal stripe, no uniform spotting laterally, and the ventral surface uniformly stippled with brown. Van Denburgh (*loc. cit.*) states that the snake was canary yellow, purple, and black before preservation.

Masticophis barbouri (Van Denburgh and Slevin), 1921

The second and third examples of this insular species were collected on Espíritu Santo Island. SU 14040 was collected by John P. Figg-Hoblyn on April 5, 1952. It is an adult male, 872 mm. from snout to tip of tail,

head length 24 mm., tail length 176 mm. (incomplete). The dorsal scale row formula is 19–17–13. There are 194 ventrals and 68 caudals (incomplete). There are 8 supralabials and 9 infralabials. SU 16068 was collected by Figg-Hoblyn on March 23, 1953. It is also an adult male, 701 mm. from snout to tip of tail, head length 21 mm., tail length 226 mm. The dorsal scale row formula is 19–17–13. There are 195 ventrals, 141 caudals (tail presumably complete), 8 supralabials, and 9 infralabials.

In details of coloration, these specimens agree closely with the type, which is an adult female larger than either of the two recently acquired specimens. The color above is a uniform olive-brown extending onto the ventrals. Along each side, a single white stripe is located on the medial half of the fourth scale row and on the lateral half of the third scale row, and fades out at the anal plate. This stripe is edged narrowly with black. Anteriorly, this stripe is dilated at intervals of 4 or more scales. The sides of the head are spotted with white; there are two spots posterior to the eye, and a white line extends anteriorly from the eye to the tip of the snout. The upper quarter of the supralabials is blackish-brown. The remainder of the supralabials and the infralabials, chin, and neck are white, lightly flecked with darker spots, which appear blue under the microscope. The anteriormost ventrals are suffused with salmon and bear a few spots of blue. The remainder of the ventral surface is an immaculate white.

This species is closely related to *Masticophis lateralis* and also to *M. aurigulus,* but I disagree with Ortenburger (1928, p. 68), who assumes it to be an annectant between *lateralis* and *aurigulus.* I consider it to be a distinct species derived from *lateralis* by isolation in an insular environment.

Masticophis bilineatus Jan, 1863

This species, previously unknown from the Gulf of California, was found on two islands, Tiburón and San Esteban.

Hensley (1940, p. 272) described a subspecies, *Masticophis bilineatus lineolatus,* from 4 specimens collected in the north branch of Alamo Canyon, Ajo Mountains, 12.9 miles south and 5 miles east of the Ajo-Tucson-Sonoyta Junction in Organ Pipe Cactus National Monument, Pima County, Arizona, May 23, 1949. He used four characteristics to differentiate his race from the common Arizona form:

Masticophis bilineatus bilineatus: (1) Dorsolateral light stripe comprises the upper half of the third and lower half of the fourth scale row. (2) Dorsolateral light stripe originates on fourth scale row posterior to last supralabial. (3) Chin spotting is very light or usually not evident. (4) The pattern of dots on the edge of the ventrals is not evident enough to warrant calling them a definite stripe.

M. b. lineolatus: (1) Dorsolateral light stripe is narrower, comprising only the upper quarter of third scale row and lower quarter of fourth scale row. (2) Dorsolateral light line originates 7.75 scale rows posterior to the last supralabial. (3) Chin spotting is pronounced and blotches occur in the neck region and on the anterior portion of the ventrals. (4) There is a definite dark stripe on the lateral edges of the ventrals.

The four examples from Isla San Esteban (SU 14041–43 and 16069) and Tiburón (SU 14044) are like Hensley's subspecies in these four characteristics. An examination shows coastal Sonora material to be intermediate in these characteristics. I hesitate to refer these insular examples to Hensley's subspecies until further specimens are collected and a more substantial geographical distribution pattern is outlined.

Data on the insular specimens examined are as follows:

San Esteban:

14041 (male)	208 ventrals,	139 caudals,	dorsolateral line originates on 7th scale posterior to last supralabial.
14042 (female)	204 "	137 "	. . . on 7th scale
14043 (female)	206 "	142 "	. . . on 6th scale
16069 (female)	197 "	incomplete	. . . on 6th scale

Tiburón:

14044 (male)	206 "	139 "	. . . on 7th scale

Masticophis flagellum piceus (Cope), 1892

This subspecies is now known to occur on eight islands in the Gulf of California: Cerralvo, Espíritu Santo, San José, Monserrate, Carmen, Coronado, Ildefonso, and Tiburón. The three examples of this race (SU 14062–64) collected on Cerralvo constitute a new insular record.

The three specimens from Cerralvo are very dark brown; almost black dorsally, with no white flecks or dots. The top of the head is somewhat lighter brown. The supralabials and lateral scales anterior to the eye are of a lighter olive-brown and have suffusions of cream. The infralabials have small patches of white. The dark dorsal coloration extends to the edge of the ventrals, which are cream colored, except in the neck and chin regions which are heavily suffused with the dorsal ground color.

Klauber (1942, p. 93) states that the three specimens from Espíritu Santo are "dark brown to black with light longitudinal dashes. One is as dark as any from Tucson."

Five specimens from Isla San José were available for comparison (SU 14046–48 and CAS 52548–49). The dorsal ground color is yellow. There is a dark gray suffusion on the neck posterior to the parietals, which extends to the 12th–15th ventral and contains 4–5 irregular narrow light bands. The anterior third to half of the body length has dark punctations on the dorsal scale tips (or on their edges) which appear as wavy thin bands. There are gray-black blotchings of no definite pattern on the labials and under the throat. Anteriorly there are four rows of spots on the ventrals. The paired medial rows of these spots are regular and are found on each ventral on the anterior third of the body, fading out posteriorly. The lateral rows of spots are larger and extend farther back, but occasionally skip a ventral.

Five specimens from Monserrate Island were available for study (CAS 52178–52182). The dorsal ground color is dark brown, becoming lighter toward the tail. The side of the head is blotched with cream and the crown is olive-brown. There are numerous yellow markings on the edges of the scales posteriorly. The ventral surface varies from yellow to cream. A very irregular series of brown blotches on the ventrals extends posteri-

orly for about half the body length. The neck and chin region are mottled with extensive suffusions of gray brown. CAS 52180, a young specimen, is lighter than the rest and has a more regular pattern.

Klauber (1942, p. 93) states that the one known example from Carmen is "a yellowish specimen with punctated head."

There is but one known example of this race from the tiny island of Ildefonso (CAS 51717). It is colored very similarly to Monserrate examples, except that the ventral surface is very heavily suffused with brown.

Thirteen specimens were collected on Isla Coronados in four hours, on a cloudy day (SU 14049–61). They were seen in the branches of bushes and lying motionless out in the open. These snakes are of the dark color phase. All thirteen are very similar in color pattern, but the young are somewhat the lighter. There is a narrow white edging on some of the lateral dorsal scales. The ventral surface is cream, suffused with large gray spots in the neck and chin region. The spotting changes from large spots anteriorly to scattered flecks posteriorly. SU 14056 is almost as dark as specimens from Cerralvo.

Klauber (1942, p. 93) states that on Tiburón Island both the light and dark phases of the whip snake are found. CAS 53245 from this island is extremely melanistic. There are no light marks on the labials or on the sides of the head and the ventral surface is suffused with dark as far as the anal plate. Even the under surface of the tail is tinged with dark. The dorsal coloration gradually lightens posteriorly and the tail is brown with darker suffusions on part of almost every scale.

In ventral and caudal counts, and in head scales, all insular specimens fall within the limits of variation ascribed to the wide-ranging mainland population. It is interesting to note that on each of the islands (disregarding Carmen and Ildefonso, from each of which we have only one specimen) a particular color phase has become established. Tiburón, a large coastal island, is the only exception. Since intermediates are found stabilized on islands, it seems possible that color is dependent upon stabilization of not only one pair of genes, but also upon one or more pairs of modifying genes as well.

Phyllorhynchus arenicola Savage and Cliff, 1954

This interesting species is endemic to Monserrate Island. It is a member of the *decurtatus* section of the genus, readily distinguished from all other forms of *Phyllorhynchus* by the following combination of characteristics: (1) Dorsal body blotches 30–32 in number, at least twice as wide as light interspaces when measured longitudinally near midbody; at least one-fourth of these blotches partially split by a light medial area. (2) Four to 6 lateral scale rows suffused with brown; this suffusion not extending onto back between dorsal blotches. (3) Lateral spots large, distinct. (4) Ventrals 164 in the male, 172 in the female. (5) Caudals 39 in the male, 31 in the female.

Salvadora hexalepis hexalepis (Cope), 1867

Two specimens of this subspecies are recorded from Tiburón Island. Although the island lies near the proposed line of intergradation between

hexalepis and *deserticola*. Bogert (1945, p. 13, fig. 10) places these two examples as members of the typical subspecies.

Salvadora hexalepis klauberi Bogert, 1945

The first known example of this subspecies to be reported on any Gulf island was collected on San José Island by Jon Lindbergh on April 11, 1952 (SU 14016). It is an adult male with 197 ventrals and 96 caudals. This snake seems referable to *S. h. klauberi* on the basis of the fifth and sixth supralabials reaching the eye, the two loreals, and the ventral and caudal counts.

Our specimen agrees with typical *klauberi* in coloration except that the lower lateral stripe is not regularly present on the fourth scale row anteriorly (well demarcated on third and fourth scale rows in peninsular examples) and the belly is yellow (usually white or only tinged with yellow in peninsula examples).

Mr. Charles M. Bogert has examined the specimen and states (personal communication): "Except for the abnormal, small triangular scale wedged in between the last and penultimate supralabials on each side, and an extra labial below the loreals on the right side, the specimen is a rather typical *S. h. klauberi*. These extra scales in the labial series . . . have no taxonomic importance."

Sonora mosaueri Stickel, 1938

An adult male of this species (SU 14038) was removed from the stomach of a *Masticophis flagellum piceus* collected on the flats of the southwest corner of San José Island. This snake is the first of the genus to be reported from any island in the Gulf of California. The specimen was only slightly digested and it was still possible to ascertain all characteristics necessary for specific placement. The combined ventral and caudal counts exceed by one the previous upper limit of the range of the species. The scale rows are 15–14–13, ventrals 156, and caudals 49.

In addition to the insular example recorded above, one other specimen (SU 14019) of *S. mosaueri* was collected at Bahía San Carlos on the mainland. Bahía San Carlos[2] is on the Gulf side of the peninsula and lies about 3 miles south of Punta San Telmo at about 25° 30′ N. latitude and 111° 1′ W. longitude. This snake is an adult male with scale rows 15–14–13, 150 ventrals, and 47 caudals. This species has previously been known only from the vicinity of Comondú, and this example extends the range approximately 100 miles southward.

The coloration in both examples agrees with that given by Stickel (1938, p. 189). The dorsal color is slightly darker brown in the mainland snake and the terminal spots on each scale are less prominent.

The counts on both these examples further support the distinctiveness of *S. mosaueri*, which is separated from all other members of the genus by the number of scale rows (15–14–13), of ventrals (males, 150–156; female, 164), and of caudals (males, 43–49; female, 39), and by the uniform coloration. Additional material may be expected from the mainland as far south as the coast opposite San José Island.

[2]There is another Bahía San Carlos at about 27° 48′ N. latitude.

Micruroides euryxanthus (Kennicott), 1860

A single example of this Arizona and Sonora elapid was recorded by Streets (1877, p. 20) from Tiburón Island. This specimen is now USNM 8566.

Dr. Doris M. Cochran of the National Museum has kindly examined the specimen and has forwarded the information presented here. Ventrals 241, caudals 30, supralabials 7, and infralabials 6. The specimen is very faded and its color pattern now consists of black, white and gray rings. In life, the white rings were yellow and the gray rings were red. The black rings are the widest, the white rings about one quarter as wide, and the gray rings about one-half the width of the black rings.

Crotalus atrox Baird and Girard, 1853

Previous to this report, *C. atrox* was known from only one Gulf island, the coastal island of Tiburón. The specimens from that island, as might be expected, are identical with those from the mainland of Sonora. In addition, one specimen referable to this species and constituting a new insular record was captured on San Pedro Mártir Island (SU 14029) on May 4, 1952, by Dr. Reid Moran.

It is a gravid female having 185 ventrals, 22 caudals, 25 scale rows at midbody, and 5 scale rows between the supraoculars. There are 17–16 infralabials and 14–15 supralabials. The postnasal meets the upper preocular and the prenasal does not contact the supralabial. In coloration, especially in punctations, it is similar to *atrox* in Sonora, except that the posterior dorsal body blotches (the last eight) are extremely faint and only discernable when the specimen is held under water. These dorsal blotches number 34.

In all diagnostic characteristics, the snake seems to fit well within the limits of variation ascribed to *C. atrox* by Klauber (1952, table 1) except in the relationship of the head dimensions to the standard body length. This relationship indicates dwarfing. This specimen has a body length of 830 mm., a head length of 30 mm., and a head width of 22 mm. Following Klauber in his statistical studies on *Crotalus*, we find that for an *atrox* 830 mm. long we should expect a head length of 38 mm. This insular example thus falls well outside the 99 per cent confidence limits for head length as indicated by Klauber (1938, p. 24). If more specimens are collected from San Pedro Mártir Island, this insular *atrox* may well prove to be a dwarfed race.

Crotalus catalinensis, new species

Holotype (SU 15631). (Fig. 3.) Collected on Isla Santa Catalina in the Gulf of California, Mexico, by Bruce Firstman, Dr. John C. Briggs, and the author, on March 27, 1953, as it lay coiled under the shade of a large cactus.

Diagnosis: This species is allied to the *Crotalus atrox* group, but differs from others of that group in being a stunted form, with a distinctive color pattern and oddly-shaped internasals. It can be distinguished from *C. atrox* by the excessively large postcanthal, which extends laterally to separate the preocular from the postnasal, from *C. ruber ruber* and *C. ruber lucasensis* in not having the first infralabials divided transversely, and from *C. tortugensis* both in having the dorsal blotches surrounded by

well defined light scales and in having fewer punctations on the dorsal ground color.

Description of holotype: A sexually mature female. Over-all length 701 mm., length of tail 46 mm., head length 29 mm., head width 22 mm., width of proximal rattle 6.0 mm.

The scale rows number 27–25–21, with 13 rows at the center of the tail and 11 scales bordering the rattle. The ventrals number 182 and the subcaudals 20. The anal is entire. There are 13–15 supralabials and 14–14 infralabials. The second, third, and fourth supralabials are considerably reduced in size, and the fifth is slightly larger than any of the other supralabials. The rostral is very slightly higher than wide. The scales on the crown of the head comprise two irregularly kidney-shaped internasals that are about three times as long as wide. The anterior canthals are small and fit into the concavity of the kidney-shaped internasals. They meet medially and are longer than wide. The posterior canthals (prefrontals) are separated medially by two pairs of small scales and are roughly triangular in shape, being rounded anteriorly at the apex. The supraoculars are the largest of the head scales and are bordered medially by nine small scales posterior to the posterior canthal (prefrontal). The prenasals are larger than the postnasals, higher than long and in broad contact with the first supralabial on both sides. There is but one loreal on each side, but the posterior canthal extends laterally, preventing contact between postnasal and upper preocular. One small scale separates the postnasal from the supralabials. The upper preocular is the larger; the lower preocular is crescentic. Both preoculars contact with the loreal. Nine scales border the eye, including the supraocular and both preoculars. The triangular mental is longer than wide; the first infralabials are divided; the genials are long and pointed posteriorly. There are neither intergenials nor submentals. The second and third infralabials are noticeably longer, but not wider than the remaining infralabials.

The head is light gray-brown, punctated with brown above, with a faint light streak through the center of the supraoculars. The ocular light stripe extends from the third supralabial (anterior to the commissure) to the anterior edge of the eye and is not sharply defined. The sides of the head are of the same color as the crown, with the exception that the scales posterior to the eye are more heavily punctated with brown.

The dorsal ground color approximates that of the head. The 38 dorsal body blotches are medium brown in their centers and are bordered by a single row of scales of darker brown. These darker scales at the margin of the blotch are bordered by 2 rows of cream-colored scales that separate successive blotches. Both the dark and light scale margins become indistinct on the posterior quarter of the body. Anteriorly the blotches are elongate. In the center of the body, they are of a rounded diamond shape and extend farther laterally. The bordering scales lose their darker hue posteriorly. The blotches are about 7 scale rows wide and 4 scales long in the center of the body. Below the dorsal blotches on either side there is a row of smaller blotches. One of these smaller blotches (slightly the larger) falls below the lateral point of each dorsal blotch, the other between each pair of dorsal blotches. The posterior 9 dorsal blotches coalesce with the larger lateral blotches.

The venter is buff, lightly suffused with gray laterally. The chin and neck region are immaculate. Dorsally, the tail has 5 black rings, which are 4 to 5 scale rows wide medially and taper to a point laterally, except for the posteriormost ring. This is only one and one-half scale rows wide and borders the rattle. The interspaces between the rings are slightly narrower than the dark rings, at least medially; are somewhat darker than the ground color of the body, and are more heavily punctated with brown. The under surface of the tail is darker and more heavily punctated than the venter and in its center has a suffusion of brown-black punctations which forms an indefinite ventral medial stripe. The anterior rattle matrix is black. Only the button is present, no rattles have developed.

Relationship: One would expect this new rattlesnake to be closely related to either *C. ruber ruber* or to *C. ruber lucasensis*, simply because it occurs on Santa Catalina Island which is nearly opposite the intergrading area of these two subspecies on the mainland of Lower California. If color pattern alone were considered, the new snake would appear most closely related to *C. r. lucasensis*. In having the canthal separating the preocular and postnasal, it is typical of *C. ruber ruber*. In having the first infralabial undivided, it is characteristic of neither species. However, it seems likely that this snake is most closely related to *C. ruber*, and has evolved its differences in response to insular isolation.

The ovaries of this specimen were examined by Dr. Malcolm Miller of the Department of Anatomy of Stanford Medical School who reports that the animal did not ovulate this year, but was sexually mature. Since the specimen is only 701 mm. long, this indicates that the animal is dwarfed.

Crotalus enyo cerralvensis, new subspecies

Holotype (SU 14021). (Fig. 4.) Collected on Isla Cerralvo in the Gulf of California on April 3, 1952, by John Figg-Hoblyn, Jay M. Savage, and the author, as it lay coiled in the shade of a bush in the dunes on the southwest coast.

Paratype (CAS 84834). Collected by Dr. G. Dallas Hanna, March 22, 1953. It was buried in a talus slope near the remains of the old Ruffo Ranch on the western coast of Cerralvo Island.

Diagnosis: This subspecies is closely related to, and obviously derived from, the mainland *Crotalus enyo*, from which it can be distinguished in having a higher number of ventral and caudal scales and a proportionately smaller head.

Description of holotype: A mature male, over-all length 765 mm., tail length 72 mm., head length 26.5 mm., head width 17 mm., width of proximal rattle 9.5 mm.

The scale rows are 27–23–19, with 11 rows at the center of the tail; 10 scales border the rattle. The ventrals number 167 and the subcaudals 31; the anal plate is entire. There are 13–13 supralabials and 12–14 infralabials. The fourth supralabial is the only noticeably enlarged labial. The rostral is equal in height and width. The scales on the crown are ridged and knobby and include two rounded triangular-shaped internasals. Posterior to the internasals, a single round canthal meets the

supraocular. The supraoculars are the largest scales on the top of the head. The prenasals are larger than the postnasals, square in form, and contact the first supralabial on either side. There are three loreals on either side. The most dorsal loreal lies caudad to the remaining loreals, which separate the preoculars from the prenasal, but does not interfere with the contact of the canthal with the supraocular. The upper 2 loreals are smaller than the lower loreal. Two small scales on either side separate the postnasal from the first supralabial. The upper preocular is larger than the lower preocular. The lower preocular contacts only the lower loreal, but the upper preocular meets all three loreals. Eight scales border the orbit. The triangular mental is slightly wider than long. The first infralabials are undivided. The 2 genials are touched by 3 infralabials on one side and by four on the other, and converge toward each other to form a point medially. There are neither intergenials nor submentals. All dorsal body scales are keeled except for the rows bordering the ventrals.

The ground color of the head is a heavily punctate gray above. From the first dorsal body blotch arise two brown diverging fingers that extend to the posterior border of the postocular. The posterior half of the supraocular is olive; the anterior half is light gray bordered by a narrow stripe of dark brown. The postocular light stripe extends from the upper corner of the eye, passing above the commissure to fuse with the light ground color below the first body blotch. This stripe is limited above by the finger of the first dorsal blotch and below by the gray-brown color that begins at the angle of the jaws and extends forward to include the upper labials; it continues beneath the eye to the posterior edge of the sensory pit. The preoculars are less punctate and appear to be of approximately the same color as the postocular light stripe.

The body pattern consists of 34 dorsal blotches, of which the first 10 are rectangular with light areas in their centers, and the remainder are rounded diamonds without light centers. A secondary series of black spots appears laterally on each side. The dorsal blotches are outlined in black, and surrounded by a light area about one to two scale rows wide. This light area extends to the lateral apex and diverges around the secondary series of blotches that are opposite the dorsal blotches. The lateral scales enclosed by the light scales are heavily punctated and give the appearance of another lateral series of blotches. Posteriorly, the secondary series of spots merges with the dorsal blotches.

The ventral surface is buff, heavily dotted with gray and brown. The chin and neck region is less spotted. The lower labials are heavily suffused with gray.

The dorsal surface of the tail has six indistinct light brown tail rings. The ventral surface is punctated like that of the venter of the body. The anterior rattle matrix is black; the rattle string is incomplete.

Paratype: The single paratype is a female, over-all length 681 mm., tail length 44 mm., head length 21 mm., head width 16 mm. It has 25 scale rows at midbody, 181 ventrals and 23 subcaudals.

In coloration, it is quite similar to the type, being slightly darker in ground color. Unfortunately, the head was injured in its capture and the

details of head squamation are difficult to ascertain. It does differ from the type in having only 2 loreals.

Comparisons: This island subspecies differs as follows from *Crotalus enyo enyo:*

	Mainland	Cerralvo
Ventrals, males	157–168	167
Ventrals, females	164–177	181
Caudals, males	22–28	31
Caudals, females	18–23	23
Ratio of head to body length	22.5–25.8	28.9–32.5

Crotalus enyo enyo Cope, 1861

This beautiful rattlesnake is known from the following islands in the Gulf of California: Espíritu Santo, including Partida portion; San Francisco, and Carmen.

The Espíritu Santo examples were taken on successive years. SU 14022 is a male and has 23 dorsal scale rows at midbody, 160 ventrals, and 26 caudals. The total length is 751 mm., the head length 28 mm. SU 15630 is also from Espíritu Santo and is a female with 23 dorsal scale rows at midbody, 167 ventrals, and 21 caudals. The total length is 581 mm., the head length 25 mm.

Our single San Francisco Island example (SU 15629) is an immature female only 349 mm. in total length with a head length of 19 mm. It has 23 scale rows at midbody, 166 ventrals, and 21 caudals. There are 13 supra- and 13 infralabials.

Two specimens were collected near a deserted ranch building on Carmen Island. The larger (SU 16532) was collected by the author, under a piece of tin roofing that was exposed to the sun. The heat under the tin roofing was extreme and it was surprising to encounter a rattlesnake there. This specimen, a female, had 23 scale rows at midbody, 173 ventrals, and 22 caudals. The total length is 653 mm., the head length 26 mm. SU 15633, a small immature female, has 25 dorsal scale rows at midbody, 171 ventrals, and 22 caudals. The total length is 338 mm., the head length 18 mm.

Crotalus mitchelli mitchelli Cope, 1861

This subspecies has been noted by Klauber (1936, p. 176) to occur on Cerralvo, Espíritu Santo, and San José islands. He notes that the single specimens examined from San José and Cerralvo are quite typical of *C. m. mitchelli* and that the three examined from Espíritu Santo are somewhat intermediate between the two mainland forms, *C. m. mitchelli* and *Crotalus m. pyrrhus,* but somewhat closer to *mitchelli.*

The author has seen two other examples of this subspecies from Gulf islands. An adult male from San José Island (SU 14030) has 166 ventrals, 27 caudals, 18–17 supralabials, 16–15 infralabials, 36 body blotches and 25 scale rows at midbody.

The other example of this subspecies (SU 14031) constitutes a new record for Carmen Island. It was collected in the vicinity of Puerta Ballendra, April 18, 1953, by John P. Figg-Hoblyn and Jon Lindbergh. It is an adult female which has 175 ventrals, 19 caudals, 16–17 supralabials, 15–14 infralabials, 39 body blotches, and 27 scale rows at midbody.

It is 690 mm. in body length, has a tail length of 44 mm., a head length of 22 mm., and a head width of 28 mm.

Crotalus mitchelli muertensis Klauber, 1949

This dwarfed insular race was recently described by Klauber (1949, p. 97) from 19 specimens. It is endemic to El Muerto Island, which lies near Encantada Grande (wrongly called San Luis on charts) at Lat. 30° N. El Muerto is the fifth of the 6 small islands extending northward from Encantada Grande and seems to be the only island of the Encantada group that is inhabited by rattlesnakes.

This race is closely related to, and undoubtedly derived from, *C. m. pyrrhus* from the adjacent mainland. It differs from *pyrrhus* in its small size (largest specimen only 637 mm.), in having 24 or fewer scale rows at midbody (*pyrrhus* usually has 25 or more), and in having fewer body blotches (32–39, average 35.7).

Crotalus mitchelli pyrrhus (Cope), 1866

Five specimens of this subspecies are known from Angel de la Guarda Island, according to Klauber (1936, p. 176). Head proportions separate *C. m. mitchelli* from *C. m. pyrrhus,* and these specimens are typical of *pyrrhus.* In ventrals, Klauber notes that the insular representatives have slightly higher counts than specimens from the mainland. It is of interest to note that the specimens from Angel de la Guarda are very large, which is very unusual in an island population. This island, however, is one of the largest in the Gulf. Klauber also states that if a large series were available, differences in the ventral counts might be significant enough to warrant subspecific recognition of the insular population.

Crotalus molossus estebanensis Klauber, 1949

The third specimen of the San Esteban rattlesnake (SU 14020) was collected by Jay M. Savage and the author as it was seen escaping toward a talus slope at the mouth of a narrow canyon on the southeastern end of San Esteban Island on May 6, 1952. This subspecies was previously known from only the type specimen (LMK 26792) and a single paratype (USNM 64586).

Klauber (1949, p. 104) differentiates this subspecies from the nearby mainland form on differences in pattern, body proportions, and on a higher number of dorsal blotches.

The Stanford example is an adult male, 890 mm. in body length, with tail length 61 mm., and head length 41 mm. It has six rattles. There are 187 ventrals and 25 caudals. The scale rows are 33–27–21. The scales on the crown consist of two large triangular-shaped internasals which are almost broken to form a pair of canthals, and 2 prefrontals that are wider than long. Three large irregular scales, behind the prefrontals, extend between the supraoculars. The supraoculars are undivided. The other scales on the top of the head are quite small except for a pair of elongate obliquely situated scales, which border the posterior medial surface of the supraoculars and are about the size of 3 of the other scales in that region placed end to end. The rostral is wider than high. The prenasal barely touches the supralabial on one side and is excluded from contact on the other by the small scales anterior to the pit; these scales

number 7 on one side and 8 on the other. On each side, the 2 loreals separate the postnasal from the preoculars. A small scale on each lateral edge of the prefrontals separates the upper preocular from the prefrontal and the supraocular from the upper loreal. The upper preocular is the larger. Including the supraocular and preoculars, 10 scales border the orbit on one side and 9 on the other. A minimum of 3 scale rows separates the orbit from the supralabials. The supralabials number 18–19, the infralabials 16–16. There are no intergenials or submentals and the first infralabial is undivided. Three infralabials contact the genials on each side.

The head has a prominent dark brown patch on the crown in the internasal-prefrontal region. A faint ocular stripe beneath the eye fuses with the lighter supralabials about 3 scales anterior to the commissure. The more posterior ocular stripe is almost obsolete.

The dorsal pattern consists of 39 olive-brown blotches which have no light areas in their centers and are separated dorsally by only one row of light gray scales. The narrow blotches extend laterally to the edge of the ventrals. The light borders of the dorsal blotches divide laterally and form lateral light-ringed circles which are more evident than the dorsal blotches, but become obscured anteriorly and posteriorly as do the dorsal blotches. Neither the circles nor the blotches can be distinguished unless the specimen is held beneath water. The 3 distinct tail rings are brownish-black anteriorly. Posterior to these, the tail is uniform black-brown. Below, the tail is spotted with gray anteriorly, but, posteriorly, changes to the brownish-black of the dorsal surface. The ventral surface of the body is cream, with brown punctations extending laterally.

In life, this rattlesnake appeared to be an irridescent dark green when viewed from a distance. In preservative, it lost this sheen and appears brownish-olive.

The main difference between this specimen and those seen by Klauber is that its crown is darkened, as in mainland *C. molossus molossus*. The best key character to separate the island subspecies from the typical subspecies is, therefore, the higher number of dorsal blotches.

Crotalus molossus molossus Baird and Girard, 1853

A single male example of this subspecies is known from Tiburón Island (MVZ 36490). It was collected by Charles G. Sibley on November 10, 1941.

This is an extremely faded specimen, with the ground color light tan. Due to this fading, it was impossible to count accurately the number of dorsal blotches, even when the specimen was held beneath water. An approximation of the number of blotches was attempted by using the lateral extensions of the dorsal blotch as a guide. This resulted in an estimate of 32–36 blotches. The head is extremely faded, also, and there is no indication of a darkening on the crown.

Ventrals number 184, caudals 25, supralabials 17–16, infralabials 16–16. Dorsal scale formula is 31–26–20.

The tail is dark brown with indications of 6 obscure darker rings. This suffusion of dark brown is extended onto the ventral surface of the tail. The ventrals and chin region are immaculate white.

Crotalus ruber lucasensis Van Denburgh, 1920

The San Lucan rattlesnake is known to occur on only one island in the Gulf of California, San José Island. Two males were collected by members of the first *Orca* expedition (SU 14023–24). Both are large and fully mature and have 192–190 ventrals, 23–22 caudals, 34–32 dorsal blotches, and 27 scale rows at midbody. Each has 2 loreal scales in front of the preoculars. These specimens are not typical of mainland *C. r. lucasensis* and lean somewhat toward *C. r. ruber,* at least in the high number of ventrals and body blotches. In having 2 loreals and 27 scale rows at midbody, however, they are characteristic of *C. r. lucasensis.* In coloration, they are definitely closer to *lucasensis* and on this character I am assigning them to this subspecies. *C. ruber ruber* tends toward red or red-brown, while *lucasensis* is straw-colored, with white scales bordering the blotches in the center of the body. The anteriormost and posteriormost body blotches are poorly defined and can be counted only with difficulty. The tail is light gray with narrow black rings 2 or 3 scales in width. The anterior rattle matrix is black.

Both specimens were collected in the early evening and were quite docile, not bothering to rattle even when approached closely. Klauber has seen 3 additional specimens from this island and assigned them to *C. r. lucasensis.*

Crotalus ruber ruber Cope, 1892

This subspecies is known to occur on the following Gulf islands: Monserrate, San Marcos, San Lorenzo, Angel de la Guarda, and Pond. Klauber has examined specimens from all of these islands, and none differs significantly from mainland representatives of this subspecies.

This rattlesnake was very common on Monserrate, and although only two were collected (SU 14025–26), tracks were very numerous in the dunes and on the floors of rocky canyons. Both specimens were lying in the shade of rocks and even though they were approached within a few feet, they did not coil or rattle.

One specimen was collected on San Marcos (SU 14027) as it lay coiled under a bush.

The two specimens from Monserrate are males. SU 14025 has 192 ventrals, 23 caudals, and 27 scale rows at midbody. It is quite noticeably faded in pattern anteriorly and is more brown than red. SU 14026 has 190 ventrals, 23 caudals, and 27 scale rows at midbody; it is a small specimen and is not faded anteriorly.

SU 14027 from San Marcos has 189 ventrals, 27 scale rows at midbody, and 20 caudals; it is darker than the other 2 specimens.

Crotalus tortugensis Van Denburgh and Slevin, 1921

Crotalus tortugensis is a well-known endemic on Tortuga Island. It is a member of the *atrox* group, and is definitely most closely related to *atrox,* rather than to *ruber* or *exsul.*

As Klauber points out (1930, p. 10), the postnasal-preocular relationship and the head size are the most important characteristics that distinguish *atrox* from *tortugensis.* Of the *atrox* specimens, 94 per cent have contact between the postnasal and preocular, or such contact is prevented by an upper loreal; 3 per cent have such contact prevented by a lower loreal-canthal contact, and 3 per cent are intermediate or borderline cases.

In *tortugensis,* on the other hand, an exactly opposite ratio exists, only 3 per cent have a postnasal-preocular contact; 94 per cent have the contact prevented by a lower loreal-canthal contact; and again, 3 per cent are borderline intermediates. The ratio of the head length to body length is smaller in *tortugensis* than in *atrox* and indicates dwarfing.

Distinctive characteristics: Dorsal coloration is gray and punctated with brown. Dorsal blotches vary from 32 to 40 (averaging 37). They are purplish brown, poorly defined and with light borders only medially. Head markings not well defined. Scale rows 27, occasionally 25; ventrals in males 180–190 (average 184), in females 183–189 (average 186); caudals in males 22–25 (average 24), in females 16–19 (average 18).

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ARTIFICIAL KEY TO THE SNAKES ON THE ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

1a. A rattle or large horny button on tail; a sensory loreal pit between nostril and eye.
2a. Prenasals separated from rostral by a row of small scales or granules.
3a. Last supralabial twice as long as those before it; head of adult contained in over-all body length more than 24 times. . . . . *Crotalus mitchelli mitchelli*
3b. Last supralabial not conspicuously enlarged; head of adult contained in over-all body length less than 24 times.
4a. Scale rows usually 23 or fewer; size small, less than 650 mm. . . . . *Crotalus mitchelli muertensis*
4b. Scale rows usually 25 or more; adults larger than 650 mm. . . . . *Crotalus mitchelli pyrrhus*
2b. Prenasals in contact with the rostral; no granules between rostral and prenasal.
5a. Tail with alternating black and ash-gray rings.
6a. First infralabial usually divided.
7a. A single loreal; scale rows 28 or more; body color red or red-brown. . . . . *Crotalus ruber ruber*
7b. Two or more loreals; scale rows 27 or fewer; body color yellow, brown, or olive-brown. . . . . *Crotalus ruber lucasensis*
6b. First infralabial usually not divided.
8a. Upper preocular usually not in contact with the postnasal, and no upper loreal present.
9a. Light scales surrounding the dorsal blotches; very few punctations on dorsal ground color. . . . . *Crotalus catalinensis*
9b. Light scales evident only on the mid-dorsal scale rows surrounding blotches; very heavily punctated with darker spots and flecks on dorsal ground color. . . . . *Crotalus tortugensis*
8b. Upper preocular usually in contact with the postnasal, or such contact prevented by an upper loreal. . . . *Crotalus atrox*
5b. No alternating black and ash-gray rings on the tail.
10a. Scales on crown knobby with a definite keel in their centers.
11a. Head contained in body length less than 26 times. . . . . *Crotalus enyo enyo*
11b. Head contained in body length more than 28 times. . . . . *Crotalus enyo cerralvensis*
10b. Scales on crown flat, though their edges overlap.
12a. Body blotches more than 37. . *Crotalus molossus estebanensis*
12b. Body blotches fewer than 38. . *Crotalus molossus molossus*
1b. No rattle or button on tail; no pit between nostril and eye.
13a. No elongate chin shields between lower labials. . . . . *Lichanura roseofusca*
13b. One or more pairs of elongate chin shields.
14a. Internasals fused with nasals; rostral enlarged.
15a. Prefrontals in contact medially. . . . *Chilomeniscus cinctus*
15b. Prefrontals widely separated medially.
16a. Ventrals number 130 or more. . . . *Chilomeniscus savagei*
16b. Ventrals number 121 or fewer. *Chilomeniscus punctatissimus*

14b. Internasals and nasals present; rostral enlarged or not.
17a. Rostral plate with free lateral edges, conspicuously enlarged.
18a. A series of body blotches across dorsum; no longitudinal stripes. . . . . *Phyllorhynchus arenicola*
18b. No series of body blotches across dorsum; a pattern of longitudinal stripes.
19a. Two supralabials reaching the eye. . . . . *Salvadora hexalepis klauberi*
19b. One supralabial reaching the eye. . . . . *Salvadora hexalepis hexalepis*
17b. Rostral plate not conspicuously enlarged.
20a. A pattern of orange, red, and black rings on head, body, and tail. . . . . *Micruroides euryxanthus*
20b. No pattern of rings on body, head or tail; stripes present or not.
21a. Scale rows at midbody 23. . . . *Lampropeltis catalinensis*
21b. Scale rows at midbody 19 or fewer.
22a. Scale rows at midbody 14. . . . . *Sonora mosaueri*
22b. Scale rows at midbody more than 15.
23a. A pattern of small brown blotches on dorsum, with a large blotch or blotches on the nape.
24a. Two rows of blotches mid-dorsally, separated by a median stripe a scale or less in width. . . . . *Hypsiglena torquata venusta*
24b. Dorsal row of blotches single; no median light stripe.
25a. A narrow median nuchal blotch 1-4 scales wide. . . . . *Hypsiglena torquata tortugaensis*
25b. Median nuchal blotch much wider than 4 scales.
26a. Gulars posterior to chin shields enlarged; 43 caudals in the two known females. . *Hypsiglena torquata gularis*
26b. Gulars not enlarged; caudals 42-54 in females . . . . . *Hypsiglena torquata ochrorhyncha*
23b. No pattern of blotches on dorsum and no well-defined blotch on the nape or lateral to the nape.
27a. No well-defined longitudinal light stripes on body. . . . . *Masticophis flagellum piceus*
27b. Well-defined longitudinal light stripes on lateral body scales.
28a. Pattern consisting of one or more dark lateral stripes. . . . . *Masticophis bilineatus*
28b. Pattern consisting of a single light lateral stripe interrupted at intervals of 4-7 scales. . . *Masticophis barbouri*

Distribution of Snakes on Islands in the Gulf of California, Mexico

(X = occurrence, E = endemic)

	ÁNGEL DE LA GUARDA	CARMEN	CERRALVO	CORONADOS	EL MUERTO (ENCANTADA GROUP)	ESPÍRITU SANTO	ILDEFONSO	MEJÍA	MONSERRATE	PARTIDA (NORTE)	POND	SAN ESTEBAN	SAN FRANCISCO	SAN JOSÉ	SAN LORENZO	SAN MARCOS	SAN PEDRO MÁRTIR	SANTA CATALINA	TIBURÓN	TORTUGA
LICHANURA ROSEOFUSCA GRACIA	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
CHILOMENISCUS CINCTUS	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
CHILOMENISCUS SAVAGEI	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
CHILOMENISCUS PUNCTATISSIMUS	..	..	..	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..
HYPSIGLENA TORQUATA GULARIS	..	..	..	..	..	..	..	..	..	E	..	..	..	..	..	..	..	..	..	..
HYPSIGLENA TORQUATA OCHRORHYNCHA	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
HYPSIGLENA TORQUATA TORTUGAENSIS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X
HYPSIGLENA TORQUATA VENUSTA	..	X	..	..	..	..	..	..	..	..	..	X	X	..	..	X	..	..	..	..
LAMPROPELTIS CATALINENSIS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	E	..	..
MASTICOPHIS BARBOURI	..	..	..	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..
MASTICOPHIS BILINEATUS	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	X	..
MASTICOPHIS FLAGELLUM PICEUS	..	X	X	X	..	X	X	..	X	..	..	..	..	X	..	..	..	..	X	..
PHYLLORHYNCHUS ARENICOLA	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..
SALVADORA HEXALEPIS HEXALEPIS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
SALVADORA HEXALEPIS KLAUBERI	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
SONORA MOSAUERI	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
MICRUROIDES EURYXANTHUS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
CROTALUS ATROX	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	X	..
CROTALUS CATALINENSIS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	E	..	..
CROTALUS ENYO CERRALVENSIS	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
CROTALUS ENYO ENYO	..	X	..	..	..	X	..	..	..	..	..	..	X	..	..	..	..	..	..	..
CROTALUS MITCHELLI MITCHELLI	..	X	X	..	..	X	..	..	..	..	..	..	..	X	..	..	..	..	..	..
CROTALUS MITCHELLI MUERTENSIS	..	..	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
CROTALUS MITCHELLI PYRRHUS	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
CROTALUS MOLOSSUS ESTEBANENSIS	..	..	..	..	..	..	..	..	..	..	..	E	..	..	..	..	..	..	..	..
CROTALUS MOLOSSUS MOLOSSUS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
CROTALUS RUBER LUCASENSIS	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..
CROTALUS RUBER RUBER	X	..	..	..	..	..	..	..	X	..	X	..	..	..	X	X	..	..	..	..
CROTALUS TORTUGENSIS	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	E

Fig. 1. Gulf of California, showing principal islands.
Based on Charts No. 620, 621, 1006, U. S. Hydrographic Office.

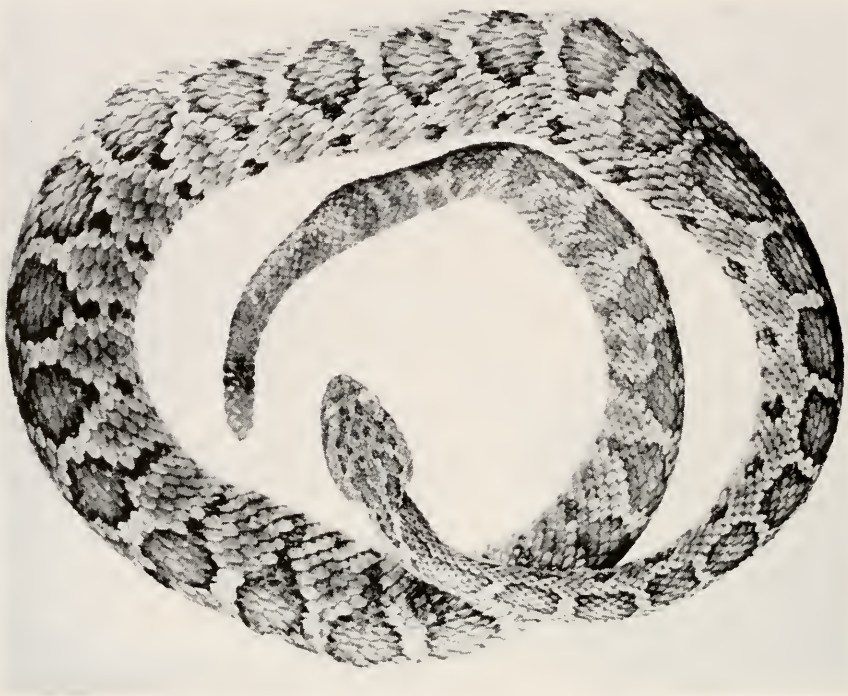

Plate 6, Fig. 3. Photograph of *Crotalus enyo cerralvensis*. Holotype (SU 14021).

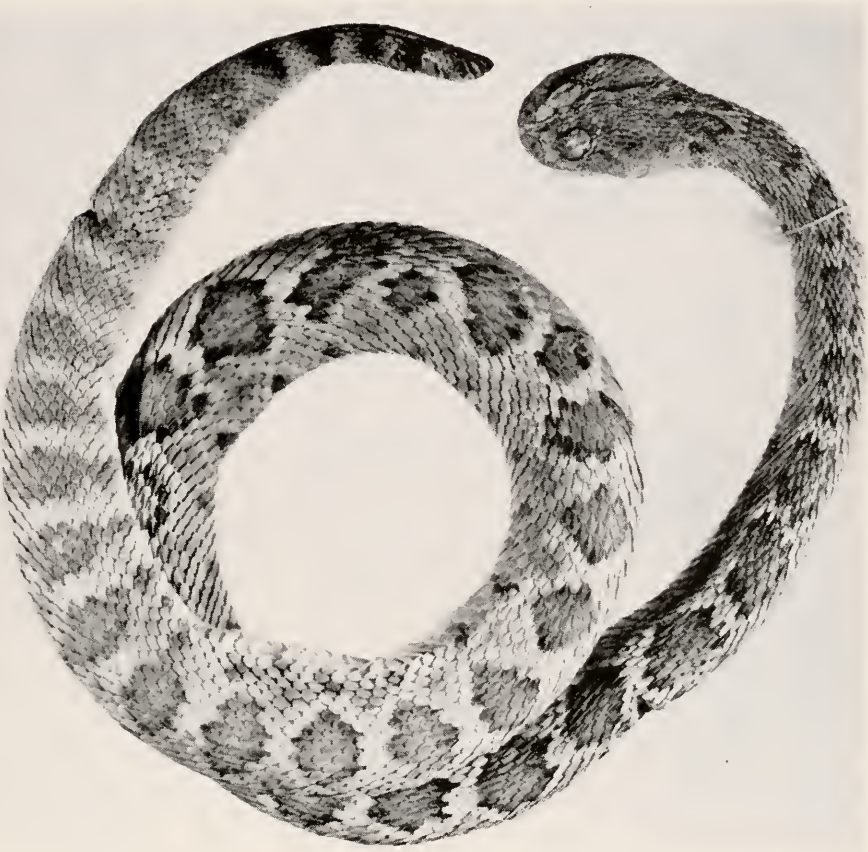

Plate 7, Fig. 4. Photograph of *Crotalus catalinensis*. Holotype (SU 15631.)

TRANSACTIONS
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A NEW RACE OF *DIPODOMYS* AND A NEW RACE OF *THOMOMYS* FROM ARIZONA

BY

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Curator of Birds and Mammals, San Diego Society of Natural History

Over a period of years there has been accumulated in the mammal collection of the San Diego Society of Natural History a series of specimens of *Dipodomys deserti* from southcentral Arizona and of *Thomomys bottae* from desert ranges in western Arizona bordering the Colorado River. The study of this material reveals sufficient characters in two geographic populations to indicate them as worthy of descriptions and new names. The *Dipodomys* may be known as

Dipodomys deserti arizonae subsp. nov.
ARIZONA DESERT KANGAROO RAT

Type.—From 3 miles southeast of Picacho, Pinal County, Arizona; No. 12532 Collection of the San Diego Society of Natural History; adult male, collected by Laurence M. Huey, May 14, 1937.

Characters.—Compared with *Dipodomys deserti deserti, D. d. arizonae* is grayish in color instead of buffy; it has a well marked undertail stripe in most specimens examined. The skull is smaller, with noticeably more rounded, inflated bullae and with a more slender rostrum. The maxillary arches of *D. d. arizonae* are more sharply angled with the axis of the skull than in either *Dipodomys deserti sonoriensis* or *D. d deserti.* Compared with *D. d. sonoriensis, D. d. arizonae* is lighter in color dorsally, with a tinge of buffy suffusion on the sides that is not present on the specimens of *D. d. sonoriensis* examined. The skull of *D. d. arizonae* differs from that of *D. d. sonoriensis* in having more rounded and massive bullae, heavier molar teeth, and wider maxillary arches.

Measurements of type.—Total length, 345; tail, 193; hind foot, 52; ear, 14. Skull: Greatest length, 45.3; width across bullae, 30.8; spread

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of maxillary arches, 23.7; greatest length of nasals, 16.2; width of maxillary arch at middle, 6.5.

Remarks.—Specimens of the race herewith named were first reported in 1937, from the Picacho area by Willett (Jour. Mamm. 18: 101). Since that year the writer has, at every opportunity, collected specimens of this species. Prior to and during this period, 139 skins and skulls have been accumulated from localities in Death Valley, Inyo County, California, and from southern Nevada southward to San Felipe, Baja California, Mexico, on the western side of the Colorado River, and from southwestern Arizona to Kino Bay, Sonora, Mexico, on the eastern side of the river. This assemblage has revealed interesting range boundaries and variations in several characters of this large Kangaroo rat. Oddly enough, the largest development in size has been found in the population living near Welton in the extremely arid southwestern section of Arizona. The further collection of specimens of comparable age may reveal this population to differ from the population of the Mojave desert region of California from whence the nominate race was named.

Range and specimens examined.—D. d. arizonae:—Arizona: 3 miles southeast of Picacho, Pinal Co., 18 (Type locality); 11 miles west of Casa Grande, Pinal Co., 11; 10 miles south of Gila Bend, Maricopa Co., 3 (not typical); 7 miles east of Papago Well, Pima Co., 2 (not typical).

D. d. sonoriensis—Mexico: Kino Bay, Sonora, 10.

D. d. deserti—Mexico: Punta Peñascosa, Sonora, 17. Arizona: Old quarry near Yuma, 1; 6 miles east of Yuma, 1; south end of Tule Desert, Yuma Co., 1; Quitovaquito, Pima Co., 1; Welton, Yuma Co., 20. Nevada: Coyote Spring, Lincoln Co., 1. California: Mesquite Flat, 8 miles north of Stovepipe Well, Death Valley, 2; Mesquite Spring, north end of Death Valley, 6; 4 miles north of Keeler, Inyo Co., 6; Mojave River, San Bernardino Co., 1 (topotype); Whitewater, San Gorgonio Pass, Riverside Co., 1; Palm Springs, Riverside Co., 2; Borego Valley, San Diego Co., 4; La Puerta Valley, San Diego Co., 10; Carrizo Creek, San Diego Co., 3; Laguna, Colorado Desert (Imperial Co.), 2; Coyote Wells, Colorado Desert (Imperial Co.), 1; 1 mile west of Pilot Knob, Imperial Co., 1. Mexico: De Mara's Well, Laguna Salada, Baja California, 5; 40 miles north of San Felipe, Baja California, 1; 30 miles north of San Felipe, Baja California, 1; San Felipe, Baja California, 7.

The *Thomomys* may be known as

Thomomys bottae cedrinus subsp. nov.

Chemehuevis Mountain Pocket Gopher

Type.—From summit of Crossman Peak, (Juniper—Piñon Belt), Chemehuevis Mountains, Mohave County, Arizona; No. 13161 Collection of the San Diego Society of Natural History; adult female; collected by Laurence M. Huey, April 27, 1938.

Characters.—Compared with *Thomomys bottae desertorum*, its nearest comparatum, which abounds in the valley floor regions to the north and east of the Chemehuevis Mountains, *T. b. cedrinus* is smaller in size and more brightly colored dorsally. The upper parts are bright deeply shaded buff, which extends well down onto the sides. There is a sprinkling of blackish hairs on the upper median surface. The undercoat is dark bluish-gray. The muzzle and fairly large auricular areas are black. The ears are small. The skull differs from that of *T. b. desertorum* in being slightly smaller and lighter boned, with zygomatic arches less sharply angled from the axis of the skull; they broaden in spread anteriorly. The rostrum is more slender and auditory bullae are larger and more roundly inflated.

Measurements.—Type: Total length, 182; tail, 53; hind foot, 24; ear, 4. Skull: Greatest length, 34.0; spread of maxillary arches 20.2; length of nasals, 12.1; interorbital constriction, 6.7; alveolar length of upper molar series, 8.1.

Range.—So far as is now known, from the summit and north slope of Crossman Peak, Chemehuevis Mountains, to the vicinity of the Lucky Star Mine on the lower slopes of the range, all within the Juniper-Piñon Belt.

Remarks.—This newly named race is a dwarf mountain-top gopher. It is found living in shallow rocky soils within the piñon-juniper area of this desert mountain range.

Specimens examined.—*T. b. cedrinus:* Summit of Crossman Peak, 4 (including type); Lucky Star Mine, 4.

T. b. desertorum: 1 mile south of Yucca, Mohave Co., 1; 3 miles south of Yucca, Mohave Co., 2; 12 miles south of Yucca, Mohave Co., 3 (all collected in a sandy, desert valley—cactus—yucca association).

Thomomys bottae desitus: Wickiup (Big Sandy River), Mohave Co., 13.

Thomomys bottae hualpaiensis: Democrat Mine, Hualpai Mountains, Mohave Co., 14.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII. No. 7, pp. 103-152. PLATES 8-11

A REVISION OF THE PACIFIC COAST PHYTOSI WITH A REVIEW OF THE FOREIGN GENERA (COLEOPTERA: STAPHYLINIDAE)

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A REVISION OF THE PACIFIC COAST PHYTOSI WITH A REVIEW OF THE FOREIGN GENERA (COLEOPTERA: STAPHYLINIDAE)

by Ian Moore

INTRODUCTION

The present study is an effort to assemble in one paper as much as could be discovered about one small group of genera of the Aleocharinae, a poorly organized subfamily of staphylinid beetles. The very large number of minute insects which are grouped together in this subfamily are represented in a great variety of environmental situations by an almost innumerable number of individuals. In spite of their abundance, the members of this subfamily are probably the least known of any large group of insects. Blackwelder stated that "Many thousands of species have been described, but comparatively few generic revisions have been published, and no adequate key to the genera has been proposed," and characterizes the situation as ". . . what appears now to be a hopeless chaos. . ."* From the foregoing remarks it would seem that any effort to assemble material and redescribe even a small number of these genera would be of some help toward a later reclassification of the subfamily. In the present study, this appears to be particularly true, because a number of characters have been discovered in the material at hand that are not recorded in the literature.

Whether the association of the genera treated here is a true phylogenetic one is open to question, and is beyond the scope of the present paper. This problem can be attacked only in a much more comprehensive study than the present available collection and library permit.

The ten genera discussed in this paper have in the past been associated by various authors in the subtribe Phytosi of the tribe Bolitocharini of the subfamily Aleocharinae. I was first introduced to this interesting group of marine insects by the late Edwin C. Van Dyke during a collecting trip to Moss Beach, California, in the fall of 1950. Later, while attempting to identify some species of *Diaulota* from Southern California, considerable difficulty was encountered which led eventually to the assembling of the material which forms the basis for this review of the group. Due to lack of material, it is not possible to present a complete revision of the foreign genera. However, for comparative purposes, these genera are included and some discussion of the species is attempted.

*Blackwelder, R. E. 1943. Monograph of the West Indian beetles of the family Staphylinidae. U. S. Nat. Mus. Bull. 182, pp. 1-658.

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MATERIAL EXAMINED

The very excellent series lent to me by Leech from the collections of the California Academy of Sciences contains all the material in this group from the Fenyes, Van Dyke, Blaisdell and Martin collections, as well as some slide preparations by E. S. Ross and by F. L. Rodgers. This material has been augmented by a fairly large series of a number of the California species collected by myself since 1950 and, except for the types and certain designated paratypes, at present in my own collection. Additional specimens which were lent by the British Museum brought the total number of specimens studied to about one thousand.

SUBTRIBE PHYTOSI

Phytosus was the first described of the ten genera now placed in this subtribe. It was first recorded by Curtis from England in 1838. A number of species of *Phytosus* have since been described from widespread localities in the northern hemisphere. None is known from the Pacific Coast of North America.* Two species of *Cameronium* are known from the east coast of

*The name *Phytosus opacus* LeConte is listed in the Leng catalogue and is retained in the supplements, although the species is also listed there, correctly as *Pontamalota opaca* (LeConte). This error has been copied in the supplement to the Coleopterorum Catalogus.

Africa. The genera *Antarctophytosus* Waterhouse and *Baeostethus* Broun are known only from the antarctic area. Three species of *Liparocephalus* Mäklin have been described from the north Pacific. The remaining four genera described by Casey are all known only from the pacific coast of North America. The species of this subtribe have in common the fact that they are all closely associated with the marine environment, either living on the seashore or in the intertidal belt. The following characters are common to all the genera examined, but have not been verified in *Baeostethus*.

1. Middle coxae contiguous, the mesosternal and metasternal processes acute and their apices separated from each other by about one-third of the length of the coxal cavities.

2. Labial palpi either two- or three-segmented, short, never as long as the mandibles.

3. Mandibles simple at tip.

4. Tarsi short. Anterior and middle tarsi four-segmented, posterior tarsi five-segmented. Last tarsal segment as long at least as the preceding two together. First segment usually no longer than the second but never longer than the second and third together.

The character of the contiguous middle coxal cavities appears to separate these genera from most other bolitocharids.* Not all authors define this character in the same manner. I consider the cavities separated only if the mesosternal process meets or nearly meets the metasternal process or if the apices of these processes are separated only by a distinct intercoxal plate. In the Phytosi both processes are acute and distinctly separated from one another by about one-third of the length of the coxal cavities. The two coxal cavities are in reality divided only by a sharp ridge which is usually not visible.

Fenyes did not follow previous workers but divided the tribe in a different way so that these genera fell into two separate subtribes, the Liparocephali (including *Actocharis, Amblopusa, Antarctophytosus, Diaulota,* and *Liparocephalus)* and the Phytosi (including *Arena, Baeostethus, Bryobiota, Bryothinusa, Phytosus, Polypea,* and *Thinusa)*. He based this division on the supposed segmentation of the labial palpi. The inclusion of *Actocharis* and *Polypea* is not in accordance with the classification of Bernhauer and Scheerpeltz, who placed the former with the Oxytelinae and the latter with the Mylaenini. As these two genera have not been seen, no attempt is

*The only exceptions known to me are certain species of *Placusa,* which can be separated by the structure of the posterior tarsi.

made here to determine their true relationships. Cameron has demonstrated that *Arena* belongs with the Myrmedoniini.

ECOLOGY

It is of interest that at least four of the Pacific Coast genera of this subtribe, *Amblopusa, Bryothinusa, Liparocephalus,* and *Diaulota,* are among the very few insects which inhabit the intertidal belt of the ocean. The remaining genera apparently occur only on the seashore, largely in decaying seaweed. Detailed illustrations of the larvae of *Liparocephalus* and *Diaulota* were published by Chamberlin and Ferris and by Saunders. Keen gave some information about the habits of *Liparocephalus* at the Queen Charlotte Islands. Nothing is known of the early stages of *Bryobiota, Thinusa, Bryothinusa, Amblopusa* and *Baeostethus,* but the larva of *Phytosus* was described by Fauvel and that of *Antarctophytosus* by Enderlein.

CHARACTERS OF GENERIC VALUE

To anyone reviewing the literature of this group of insects, it will be apparent that of the few characters which have been given generic value, several have been interpreted in different ways by different workers. In order to avoid confusion in the use of this paper, it seems worthwhile to discuss these characters and explain their use by the present author.

Labrum.—The anterior margin of the labrum may be rounded, arcuate, truncate, emarginate, or bilobed. When it is rounded, it is evenly so; when it is arcuate, the sides turn rather abruptly back from the apex. It is considered truncate if there is a considerable straight central edge, even if the outer angles are slightly rounded. It is emarginate if the outer angles are produced anteriorly to the central edge. When it is bilobed, the central edge is acutely notched in the middle. In *Thinusa,* this notch is filled with a dark membrane on a slightly more ventral plane.

Mandibles.—The mandibles may be in one plane, or they may be arched gradually downward in the apical half, a condition I have referred to as "curved ventrally." Often, on one or on both mandibles, there is a median tooth at the inner edge about halfway between the base and the apex. In *Amblopusa, Bryothinusa,* and *Liparocephalus* there are also serrations between the median tooth and the tip. *Baeostethus* is said to have three inner teeth on each mandible.

Maxillae.—The very striking variations in the inner and outer lobes of the maxillae are probably constant generically. When better known, these parts may prove to be quite useful in the classification of the genera. Unfortunately, these characters could not be fully investigated in the present

study, because some of the genera have been seen only in loan material which could not be dissected.

Labial palpi.—It has been pointed out by several authors that the number of segments of the labial palpi in many groups of Staphylinidae is an inconstant and unreliable character, variable even within some species. However, this character has been used extensively in separating genera and even higher groups. Within the Phytosi, as pointed out by Chamberlin and Ferris, the genus *Diaulota* shows considerable variation: some specimens of a species have only 2 segments, whereas in others the basal segment is divided into two, making 3 segments in all. I have observed that in the genera in which the labial palpi are always three-segmented, the basal segment is always the widest as well as the longest. In the genera in which either condition may exist, the three-segmented condition is brought about by a division of the basal segment of the two-segmented palpus, so that segments one and two are of nearly equal width, and segment one is always the shorter. If the relative widths and lengths of the segments are recorded, a great deal of confusion can be avoided. The labial palpi of *Antarctophytosus*, *Bryothinusa* and *Liparocephalus* are similar in structure to those of *Diaulota*. Although I have observed only the three-segmented condition in *Antarctophytosus*, Dr. Cameron describes the palpi as two-segmented in *Paraphytosus*, a synonym of that genus. In *Liparocephalus* I know only the two-segmented condition but have seen both types in *Bryothinusa*. In the remaining genera the labial palpi are apparently always three-segmented. Casey described *Amblopusa* as having two-segmented labial palpi, but his descriptions of the widths and lengths of the segments leads me to believe that the third segment was broken off his specimen (see accompanying illustration of *A. borealis* Casey from the Fenyes Collection).

Ligula.—The ligula is often difficult or impossible to observe in museum specimens. In most of the phytosids it is moderately developed and slender. In some species of *Diaulota* it is so small that it might be considered wanting. In *Thinusa* and *Cameronium* the ligula is bifid (perfectly Y-shaped), a condition found in many other aleocharinids but unknown in the other phytosids.

Mentum.—The mentum is trapezoidal, widest at its base, and either truncate anteriorly or moderately or deeply emarginate.

Eyes.—The eyes are never prominent, seldom interrupting the side margin of the head. They vary greatly in size. They are minute in *Amblopusa* and *Baeostethus* (with as few as 3 separate facets in *Amblopusa brevipes* Casey). In *Thinusa* they occupy more than half the side of the

head. In most of the genera setae are interspersed with the facets. In others, *Liparocephalus* for example, there are no such setae.

Antennae.—The antennae present some differences in the relative lengths and widths of the segments. The most useful of these characters are the very short third segment in *Amblopusa* and the very long tenth segment in *Bryothinusa*. The relative length of the antennae, as compared with that of the head, pronotum, and elytra, is often used to separate species and sometimes even genera. Because the antennae do not usually lie straight back over these parts, and it is very difficult to so arrange them, such estimates can be inaccurate and should therefore be used with care.

Infraorbital ridge.—This ridge is quite variable in the Phytosi, and, although apparently always lacking in some genera and always well developed in others, in some species of *Diaulota* it may be either entirely lacking or moderately developed basally. The phrase "temples margined beneath" is often used to refer to the presence of this ridge.

Pronotum.—The differences in the shape of the pronotum are largely only specific in value and often not that. In the center of the disc *Bryobiota* has a longitudinal impression that is not found in the other genera.

Hypomera.—The hypomera is always visible from the side in the Phytosi but in *Liparocephalus* it is extremely small and hard to see. Casey used its shape for separating some genera, but I am unable to make such an application.

Prosternum.—This is difficult to observe in museum specimens. The small differences I have been able to observe do not seem to have much generic value.

Elytra.—The numerous minor variations in shape and size seem to be largely specific differences. In *Thinusa* the outer edge is much longer than the suture.

Tibiae.—In most of the genera, the tibiae are clothed by a long sparse pubescence. In *Phytosus (Phytosus)*, *Phytosus (Actosus)*, and *Thinusa* the anterior and middle tibiae possess, in addition to the usual pubescence, several series of long setae. The setae, although usually referred to as spines, are not direct extensions of the chitinous integuments and each has a distinct articulation at the base. They are several times the diameter of the pubescence which is interspersed with them.

Tarsi.—Any discussion of the tarsi brings up the problem of the major classification of the Aleocharinae. The present classification is based largely on the number of segments possessed by the tarsi. In the tribe Bolitocharini, of which the Phytosi is treated as constituting a subtribe, the tarsal seg-

ments are supposed to number 4 on the anterior and middle legs and 5 on the posterior. By many authors, this tarsal classification is considered not to indicate true relationships but merely to be a matter of convenience. Actually, it is often a matter of great inconvenience. The very small size of the insects, coupled with the peculiar structure and often dense vestiture of the tarsi, makes the counting of the segments difficult and often very doubtful. Many genera have been switched back and forth from one tribe to another by different students because of the different counts arrived at. This situation undoubtedly accounts for some of the confusion surrounding the classification of the subfamily. It seems likely that a truly phylogenetic classification will be arrived at only when other characters are utilized in conjunction with the tarsal structure. Another difficulty is indicated by the observation of Chamberlin and Ferris that in one species of *Diaulota* the posterior tarsi in the majority of specimens studied are reduced to 4 segments. They state that "The proportions of the segments and the arrangement of the setae indicate that the four-segmented condition arises from a fusion of the normal fourth and fifth segments." The following characteristics seem to be of value in distinguishing the genera of the Phytosi. The anterior tarsi are short and compact in *Amblopusa*. In *Baeostethus* they are said to be so compact and so densely setose that the basal segments are not readily visible. The unique spatulate plantar setae of the posterior tarsi of *Liparocephalus* have been pointed out by Chamberlin and Ferris. Variations in the relative lengths of the tarsal segments have been used to separate some genera of the tribe. In *Thinusa* certain such variations were given specific value by Casey, but according to Fenyes' synonomy of that genus, these variations would be intraspecific.

Metasternum.—In Phytosus and some of the other genera the metasternum is long, so that there is a considerable separation of the middle from the hind coxae. In *Diaulota*, *Liparocephalus*, and *Baeostethus* the metasternum is so reduced in length that the coxae are placed together in a compact group. This is a very distinctive character which indicates, along with other structural similarities, the close relationship between *Diaulota* and *Liparocephalus*.

Basal impressions of the tergites.—In the key that follows, considerable use has been made of the presence or absence of transverse impressions near the bases of certain tergites. The number of tergites having such impressions is fairly constant within the limits of the genera, with some exceptions (the two known exceptions in this subtribe are *Thinusa* and *Diaulota*). My understanding of this character is as follows. A tergite is said to

be impressed at the base if, at the anterior margin, there is an unbounded transverse groove which extends nearly to the lateral edge. The impression will be just posterior to a raised line (the antecostal suture) which delineates the portion of the tergite (the acrotergite) that normally is beneath the free posterior edge of the preceding tergite. The impression should not be confused with the antecostal suture or with the acrotergite. When present, the impressions are visible only in the proper light, so that often a specimen must be rotated in the light in order to cast a shadow in the impression. The impressions are not ordinarily visible in slide preparations. When present, it seems to be invariable that all visible anterior tergites will be impressed up to a certain number, so that if, for example, tergite number three is impressed, tergites number one and two will also be impressed. These basal impressions seem to be of wide occurrence in the Aleocharinae. The number of segments impressed has been used extensively in classification and is usually given generic significance. However, sometimes the last impressed tergite is so faintly impressed as to be easily overlooked in a count and the number is subject to variation within some species. In *Diaulota densissima* Casey the fourth tergite is definitely not impressed in some specimens, whereas in others there is a faint impression. Under these circumstances this character even though very convenient and often easily used, must be employed with care.

Constriction of the sternites—This character is difficult to observe, since it is very similar to the basal impressions of the tergites. The first four visible sternites are constricted on *Phytosus, Amblopusa,* and *Bryobiota.* The first two of these genera have five impressed tergites, and the last one four so impressed. When the insect is viewed from the side, it will be seen that the constriction of the base of the sternite is exactly opposite the impression on the tergite, so that together they form, around the segment, a ring that is interrupted only by the paratergites. In *Amblopusa* the paratergites are obviously affected also. These two structural modifications very likely have a common cause or function, possibly allowing greater flexibility of the abdomen. I have not observed this constriction in any of the remaining seven genera, although some have strong basal impressions of the tergites.

Sexual characters.—External differences between the sexes are very weak in this group of insects. No differences have been observed in *Bryothinusa, Bryobiota* and *Thinusa.* In *Diaulota* and *Liparocephalus* a modification of the apical margin of the sixth sternite offers some characters of specific value. In the female of *Liparocephalus brevipennis* Mäklin I have discovered some very striking modifications of the fifth and sixth tergites. These are

shown in the drawing of that species. Various degrees of enlargement of the head in males of some species of *Diaulota* and *Liparocephalus* are apparently intraspecific variations.

The following key is presented in the hope that it may be of aid to students, in spite of the fact that characters could not always be chosen that are most readily visible in museum specimens. The fact that *Baeostethus* has not been seen and that certain characters have not been recorded in the original description of it has added to the difficulty of composing the key. Only two subgenera of *Phytosus* have been included. The characterization of *Phytosus s. s.* and *Actosus* are based entirely on *P. (Phytosus) spinifer* Curtis, *P. (Actosus) nigriventris* (Chevrolat) and *P. (Actosus) balticus* Kraatz. The other two proposed subgenera of *Phytosus, Euphytosus* Bernhauer and Scheerpeltz and *Anopsisus* Bernhauer have not been seen and probably do not belong here. The former is too incompletely described to permit its inclusion. If *Anopsisus* is actually a *Diglotta,* as Koch says it probably is, then the original description is certainly very poor.

KEY TO THE GENERA OF THE SUBTRIBE PHYTOSI

A. Anterior and middle tibiae spinose externally.
  B. Fifth tergite impressed at base; ligula simple.
    C. Elytra considerably longer than pronotum; metasternum long ..... *Phytosus (Phytosus)*
    CC. Elytra not or very little longer than pronotum; metasternum short ..... *Phytosus (Actosus)*
  BB. Fifth tergite not impressed at base; ligula bifid; metasternum short ..... *Thinusa*
AA. Tibiae not spinose externally; ligula simple.
  D. Anterior tarsi short, compact, so densely setose that the basal segments are not visible; mandibles with three internal teeth ..... *Baeostethus*
  DD. Anterior tarsi usually as long as middle tarsi, not densely setose.
    E. No tergites impressed at base.
      F. Right mandible very minutely serrate between median tooth and tip, left simple; mentum truncate; body slender, parallel ..... *Bryothinusa*
      FF. Both mandibles coarsely serrate between median tooth and tip; mentum emarginate; abdomen inflated, sides arcuate ..... *Liparocephalus*
    EE. At least three tergites impressed at base.
      G. Fifth tergite impressed at base ..... *Amblopusa*
      GG. Fifth tergite not impressed at base.
        H. Fourth tergite strongly impressed at base ..... *Antarctophytosus*
        HH. Fourth tergite not (or very faintly) impressed at base.
          I. Base of head longitudinally impressed ..... *Bryobiota*
          II. Base of head not longitudinally impressed.
            J. Metasternum long, hind coxae distant from middle coxae ..... *Cameronium*
            JJ. Metasternum short, hind and middle coxae very approximate ..... *Diaulota*

LIPAROCEPHALUS Mäklin

Liparocephalus Mäklin, 1853, p. 191; Casey, 1893, p. 353; Fenyes, 1918, p. 106; Chamberlin and Ferris, 1929, p. 143; Blackwelder, 1936 (various figures to parts of adult).

Generitype.—*Liparocephalus brevipennis* Mäklin.

Diagnosis.—Body broad, inflated, somewhat convex. Head variable. Labrum wide, truncate or very shallowly emarginate. Mandibles with coarse serrations between median tooth and tip, not curved ventrally at tip. Mentum deeply emarginate in central third, the emargination straight at bottom. Third segment of maxillary palpi subconical, widest at apex; fourth narrow and short. Inner lobe of maxilla broad at base, pointed at apex, densely setose within; outer lobe broad with a dense brush of setae internally at tip. Labial palpi two-segmented; first segment four times as long as wide; second half as wide as first and little more than half as long; palpi separated at base by width of first segment. Ligula simple, slender, a little less than half as long as first segment of labial palpi. Eyes moderately large, occupying about one-third of side of head; hairless between facets. Antennae with all segments elongate. Pronotum variable. Anterior margin of prosternum straight. Hypomera very small but visible from the side. Elytra short, not more than half the length of pronotum; internal apical angles rounded. Tibiae pubescent. Plantar setae of posterior tarsi spatulate. Abdomen inflated, arcuate at sides; without impressions at base of tergites; sternites not constricted at base.

Remarks.—This genus is recognizable at a glance by the inflation of the abdomen. It differs from all but *Amblopusa* and *Bryothinusa* in the serrate mandibles, but it is indicated by a number of more important characters to be most closely allied to *Dianlota*. The spatulate plantar setae of the hind tarsi have been observed in none of the other genera. Three species have been described; *brevipennis* Mäklin from Alaska, *cordicollis* LeConte from California and *takunagai* Sakaguti from Japan. The latter is apparently very similar to *cordicollis* but is said to differ in the non-dehiscent sutural margin of the elytra. Judging from an illustration given by Sakaguti it also differs from our species in the male secondary sexual characters. *Cordicollis* has been variously considered a full species, a subspecies of *brevipennis*, and a synonym of that species. In the material examined by me I find two quite distinct species, one from Alaska and the other ranging from British Columbia south to San Luis Obispo County, California. I believe these to be the two previously described North American species, although my determinations do not agree with those of most former students. In former keys, color

has been used to separate the species. My series shows that the color is quite variable and is completely unreliable in separating the species. The size and shape of the head is also extremely variable. The secondary sexual characters provide such positive means of identification in both sexes that these have been chosen for the new key.

KEY TO THE NORTH AMERICAN SPECIES OF LIPAROCEPHALUS MÄKLIN

A. Median lobe of sixth sternite of male shorter than lateral lobes; apical margin of fifth tergite of female broadly emarginate ..... *brevipennis*

AA. Median lobe of sixth sternite of male longer than lateral lobes; apical margin of fifth tergite of female straight ..... *cordicollis*

Liparocephalus brevipennis Mäklin

Liparocephalus brevipennis Mäklin, 1853, p. 192.

Description.—Densely piceous to dark reddish brown; integuments densely granulose; clothed in a short dense pubescence which is densest on the head; distinctly and rather closely punctured throughout. HEAD about as wide as long; narrower than pronotum. Eyes moderate in size, occupying not more than one-third of side of head. Temples margined beneath the eyes. Antennae about as long as head and pronotum; segments one to eight elongate, nine and ten very little longer than wide, eleventh elongate. Labrum broadly and feebly emarginate in a continuous arc. PRONOTUM a little wider than long, widest at apical third; sides arcuate to hind angles which are not sinuate; base narrower than apex. Each elytron about as wide as long and about half the length of pronotum; internal apical angles broadly rounded. ABDOMEN broadly inflated, with arcuate sides; no tergites impressed at base; sternites not constricted. MALE with sixth sternite produced apically in three rounded lobes, the median lobe shortest; fifth tergite straight at apex. FEMALE with sixth sternite arcuate apically; apical margin of fifth tergite strongly emarginate with a small, broad arcuate lobe in the center of the emargination; sixth tergite with a longitudinal ridge for its full length. LENGTH about 3.5 mm.

Type locality.—"In insula Chtaguluk ad castellum Constantinovsk," Alaska. J. B. Tompkins of the Bancroft Library at Berkeley, California, has kindly located that island for me under the present name of Hinchinbrook Island in Prince William Sound in southern Alaska.

Additional published records.—Unalaska, Alaska. Other records are doubtful because most identifications have been based on color.

Material examined.—Nine specimens of both sexes in the Blaisdell Collection (C.A.S.) from Dutch Harbor, Unalaska, Alaska, and five from the same series in the Fenyes Collection.

Remarks.—This species is quite distinct from the one I identify as *cordicollis* LeConte and can easily be separated from it by the secondary sexual characters of both sexes. The specimens collected by Blaisdell at Dutch Harbor are the only ones I have seen. If this is not *brevipennis*, it is unnamed.

Liparocephalus cordicollis LeConte

Liparocephalus cordicollis LeConte, 1880, p. 177; Chamberlin and Ferris, 1929, p. 154 (figures of adult, part).

Liparocephalus brevipennis Keen, 1897, Fig. 35; Saunders, 1928, p. 542 (figures of adult and larva), Chamberlin and Ferris, 1929, p. 143.

Description.—Densely piceous to dark brown; integuments densely granulose throughout; clothed in a short dense pubescence, which is less apparent on the head; distinctly and rather closely punctured throughout. Head broader than or as broad as long, subquadrate to round; sides behind the eyes subparallel and straight for most of the length or gently arcuate. Eyes moderate, occupying about one-fourth of side of head. Antennae about as long as head and pronotum; all segments elongate. Labrum truncate. Mentum emarginate for central third; the emargination straight at bottom. Temples bordered beneath the eyes only at base of head. Pronotum a little wider than long, widest at apical third; sides arcuate to basal angles where they sometimes become sinuate; base narrower than apex. Each elytron about as long as wide and about half as long as pronotum. Abdomen broadly inflated, with sides arcuate; tergites not impressed; sternites not constricted. Male with sixth sternite produced apically in three lobes, the median lobe longest. Female with sixth sternite arcuate. Length about 4.0 mm.

Type locality.—Mendocino, California.

Recorded distribution.—Massett, Queen Charlotte Island, British Columbia, to San Mateo County, California.

Material examined.—I have examined 156 specimens: 17 from Massett, Queen Charlotte Island, British Columbia (Fenyes Collection, C.A.S.); 1 from Tofino, Vancouver Island, British Columbia, collected by Spencer (C.A.S.); 4 from Indian River, British Columbia, H. B. Leech (C.A.S.); 8 from Vancouver, British Columbia, H. B. Leech (C.A.S.); 7 from Cannon Beach, Oregon, E. C. Van Dyke (C.A.S.); 2 from DePoe Bay, Oregon, E. S. Ross (C.A.S.); 1 from Bodega Bay, California, C. H. Hanna (C.A.S.); 1

from San Francisco, California, F. L. Rodgers (C.A.S.); 7 from Moss Beach, San Mateo County, California, F. E. Blaisdell (Fenyes Collection, C.A.S.), and 4 from the same locality, Ian Moore; 4 from Pigeon Point, San Mateo County, California, Ian Moore; 99 from Pacific Grove, Monterey County, California, Ian Moore; 1 from Piedras Blancas Point, San Luis Obispo County, California, Ian Moore. My specimens were all collected in October and the others from May to July.

Remarks.—It is possible that all records for this genus south of Alaska are based on this species. The great variability in color and in the shape and size of the head leads me to believe that most identifications as *brevipennis* are incorrect. Chamberlin and Ferris describe what they believe to be two species from Moss Beach based on "obvious differences" in the male genitalia. My own experience is that the male genitalia of *cordicollis* will appear similar to either drawing given by them if viewed from different angles.

DIAULOTA Casey

Diaulota Casey, 1893, p. 354; Fenyes, 1918, p. 105; Chamberlin and Ferris, 1929, p. 155.

Generitype.—*Diaulota densissima* Casey.

Diagnosis.—Body elongate, subparallel with slightly inflated abdomen, subdepressed. Head variable. Labrum rounded. Mandibles asymmetrical, each with a median tooth, not curved ventrally. Mentum broadly, shallowly emarginate. Maxillary palpi with third segment subovoid; fourth segment moderately elongate, slender. Inner lobe of maxilla narrowed toward the tip, strongly setose within; outer lobe with dense brush of setae at tip. Labial palpi two- or three-segmented; first segment, or first two conjointly, four times as long as wide; last segment half as long and half as wide as first, or first two together; first segment, when palpus three-segmented, only half as long as second. Ligula minute, hardly visible between the palpi. Eyes small, occupying less than one-third of side of head. Antennae with first three segments elongate, ninth and tenth transverse. Pronotum variable. Anterior margin of prosternum arcuate. Elytra short, not more than half the length of pronotum. Tibiae pubescent. Tarsi with basal segments short, equal to second; last segment elongate. Abdomen slightly inflated posteriorly; first three or four visible tergites impressed at base; sternites not constricted basally.

Remarks.—As will be pointed out in the remarks following *Amblopusa*, that genus is quite distinct from *Diaulota*. *Diaulota* seems most closely

allied to *Liparocephalus* in the very short metasternum, the short elytra, and particularly in the very close similarity of the labial palpi and the maxillae. It differs from *Liparocephalus* in the form of the mandibles, the impressed tergites, the very short ligula and many other characters, as pointed out by Chamberlin and Ferris. Until now, only one species of *Diaulota* has been known, *D. densissima* Casey, with its synonym, *D. insolita* Casey. There are in my collection four other species, which are described now.

KEY TO THE SPECIES OF DIAULOTA CASEY

A. Head densely piceous.
  B. Each elytron as long as wide; in each sex, head narrower than pronotum and antennae one-third longer than head ..... *densissima*
  BB. Each elytron wider than long; in male, head as wide as pronotum and antennae almost as long as head and pronotum ..... *fulviventris*
AA. Head transluscent, ferruginous.
  C. Head small, elongate, narrower than pronotum, narrowest near apex ..... *harteri*
  CC. Head large, as wide as or wider than pronotum.
    D. Each elytron shorter than wide; third antennal segment as long as second, very long and slender ..... *megacephala*
    DD. Each elytron longer than wide; third antennal segment shorter than second, stout ..... *vandykei*

Diaulota densissima Casey

Diaulota densissima Casey, 1893, p. 354; Saunders, 1928, p. 542 (figures of adult and larva); Chamberlin and Ferris, 1929, p. 157 (figures of adult and larva).
Diaulota insolita Casey, 1893, p. 355.

Description.—Body densely piceous above, beneath sometimes faintly paler; densely granulose, not shining; clothed in a short dense pubescence; finely densely punctured throughout, more coarsely on the abdomen. Head narrower than pronotum in both sexes, sides evenly arcuate. Antennae one-third longer than head in each sex. Eyes of about 35 facets. Temples strongly margined beneath the eyes. Pronotum a little longer than wide, widest near apical third; sides evenly arcuate to base and hardly sinuate; base definitely narrower than apex. Elytra nearly as long as wide and nearly half as long as pronotum. Abdomen subparallel but inflated slightly posteriorly. First three tergites impressed at base, fourth sometimes with a very faint suggestion of an impression. Male with sixth sternite produced in the middle in a rounded triangular lobe and at the sides produced nearly as far posteriorly, the intervening areas deeply arcuate. Female with the sixth sternite arcuate posteriorly. Length 2.0-2.9 mm.

Type locality.—Mainland opposite Fort Wrangel, Alaska.

Additional published records.—Moss Beach, San Mateo County, California; Nanaimo, Vancouver Island, British Columbia; Yakutat, Alaska. The male, a unique, was described as *D. insolita* by Casey from Queen Charlotte Islands, British Columbia.

Material examined.—Two females from Dutch Harbor, Unalaska (C.A.S.); 1 male and 1 female from Massett, Queen Charlotte Island, British Columbia (C.A.S.); 2 specimens in the British Museum from Metlakatla, "British Columbia" [Metlakatla is in southeastern Alaska], taken by J. H. Keen, labeled *D. insolita;* 6 females from Moss Beach, San Mateo County, California (C.A.S.); 1 female and 5 males from Moss Beach (Ian Moore); 7 females and 11 males from Pigeon Point, San Mateo County, California (Ian Moore); 110 females and 89 males from Pacific Grove, Monterey County, California (Ian Moore). My specimens were all taken in November, 1954.

Diaulota fulviventris new species

Description of male holotype.—Densely piceous above, dark fulvous beneath; integuments densely granulose; clothed in a short, fine, dense pubescence throughout; very finely, densely punctured, more coarsely on the abdomen. HEAD round, as wide as pronotum; sides evenly arcuate. Antennae nearly as long as head and pronotum; first three segments elongate, each narrower and shorter than the preceding, fourth to seventh ovoid, eighth to tenth transverse, eleventh obconical. Eyes of about 35 facets. Temples strongly margined beneath the eyes. PRONOTUM as wide as long; sides evenly arcuate to hind angles which are slightly sinuate. ELYTRA considerably shorter than wide and very much less than half the length of pronotum. ABDOMEN somewhat inflated posteriorly; apex of sixth sternite produced medially in a small, rounded, triangular lobe; apical edge lateral to lobe hardly sinuate. Lateral lobe of GENITALIA with enlarged apex produced at right angle to a short narrow stalk; median lobe with a small hook-like process at extremity. LENGTH 1.7 mm.

Allotype (female).—Head elongate, narrower than pronotum. Antennae one-third longer than head. Abdomen somewhat inflated but sides more arcuate posteriorly; apex of sixth sternite arcuate posteriorly.

Type locality.—La Jolla Shores, San Diego, California.

Types.—Holotype, male, allotype, female, paratypes, 6 males and 10 females taken at the type locality November 9, 1950 by Samuel G. Harter and Ian Moore, and 7 males and 14 females taken at the same locality on November 22, 1950 by Ian Moore. All specimens were collected in fine well-

drained cracks in rocks which had to be pried apart with a wrecking bar, between +4 and +6 foot tide levels in association with *Thalassotrechus barbarae* (Horn) at the higher level and with the two following species at the lower level.

Disposition of types.—Holotype, allotype, and 4 paratypes deposited in the collection of the California Academy of Sciences. Two paratypes are deposited with each of the following: San Diego Museum of Natural History; American Museum of Natural History; Museum of Comparative Zoology; Canadian National Collection; Chicago Natural History Museum; British Museum (Natural History); United States National Museum. The remaining paratypes are at present retained in my collection.

Additional material.—Thirteen specimens from the type locality taken in September and October, 1953; 16 males and 37 females from Sunset Cliffs, San Diego, California, November 21, 1950; 7 males and 4 females from Pigeon Point, San Mateo County, California, October, 1954; 6 males and 1 female from Shell Beach, San Luis Obispo County, California, October, 1950; 4 males and 5 females from Descanso Bay, Baja California, Mexico, in April, 1951, and the others in October, 1953; 7 males and 8 females from Sauzal, Baja California, Mexico, May, 1951; 1 male and 1 female from Punta Morro, north of Ensenada, Baja California, in April, 1951, and 2 males and 4 females from the same locality in November, 1954. Larvae that probably belong to this species were taken on various dates in the spring and fall at San Diego and at Punta Morro.

Remarks.—This species closely resembles *D. densissima* and might have been considered that species had it not been for the differences in the male genitalia. The females of the two species are so similar that only a very careful examination will distinguish them. The male of *fulviventris* can be separated from that of *densissima* by a number of characters such as the wider head, longer antennae, and differences in the apical margin of the sixth sternite. There are some noticeable variations in series taken from different parts of the range, but the male genitalia show no differences in specimens from Shell Beach, San Diego, and Punta Morro. The specimens from Pigeon Point and Shell Beach are darker beneath, those from Sauzal very much lighter, both above and beneath and in addition have more delicate antennae. These differences appear in the majority of the specimens but not in all, and possibly indicate enough differentiation to warrant the recognition of a slightly different "race" to the south.

Diaulota harteri new species

Description of male holotype.—Testaceous, with fourth dorsal segment a little darker; integuments finely and densely granulose except on the abdomen; pubescence fine, short, dense; very finely, rather closely punctured throughout; the abdomen with a network of fine lines connecting the punctures. HEAD distinctly longer than wide, widest at posterior fourth, very distinctly narrower than apex of pronotum; sides of head behind the eyes distinctly sinuate. Eyes of about 16 facets. Antennae nearly as long as head and pronotum; first three segments elongate, decreasing in length, third narrower than second, fourth to sixth hardly elongate, seventh and eighth round, ninth and tenth transverse, eleventh elongate, obconical. Temples strongly margined below the eyes. PRONOTUM about as wide as long, widest at apical third; sides evenly arcuate and slightly sinuate at hind angles; base narrower than apex. ELYTRA conjointly about as wide as pronotum and about half as long, each elytron nearly square except for the broadly rounded humeral angle. ABDOMEN gradually expanded posteriorly to the fifth segment; apex of sixth sternite produced in its central third in a broad, pointed triangle; margins from the base of the triangle to the sides, straight. LENGTH 1.8 mm.

Allotype (female).—Similar to male, but with sixth sternite rounded posteriorly.

Type locality.—Descanso Bay, Baja California, Mexico.

Types.—Holotype, male, allotype, female, and 26 paratypes taken at the type locality on October 11, 1953.

Disposition of types.—Holotype, allotype, and 4 paratypes deposited in the collection of the California Academy of Sciences. Two paratypes are deposited with each of the following: San Diego Museum of Natural History; American Museum of Natural History; Museum of Comparative Zoology; Canadian National Collection; Chicago Natural History Museum; British Museum (Natural History); United States National Museum. The remaining paratypes are at present retained in my collection.

Additional material.—Seventeen specimens were taken at La Jolla Shores, San Diego, California, in September, October and November. All were collected from very narrow, well-drained cracks in rocks between +4 foot tide level and mean low water, in association with the following species. It has not been determined if they extend below mean low water, but at that point they would occasionally be submerged for as long as 16 hours at a

time. It seems likely that a film or bubble of air is retained in the cracks where they are found.

Remarks.—This species is easily distinguished from *densissima* and *fulviventris* by its very pale, transluscent, yellow or red integuments and from *megacephala* by the very narrow head. The color is variable. The type is the palest specimen seen. The usual color is ferruginous with one to three abdominal segments black. This species is named for Samuel G. Harter, who assisted on numerous collecting trips and who collected the first specimens of *Diaulota fulviventris.*

Diaulota megacephala new species

Description of male holotype.—Ferruginous, with fourth and part of fifth abdominal segments and eleventh antennal segment black; integuments transluscent, minutely and densely granulose except on the abdomen, which is rather distinctly reticulate; pubescence short, fine and dense; punctuation fine, rather dense. Head trapezoidal, very large, wider and longer than pronotum, wider than long, widest at the anterior margin; the sides slightly and evenly arcuate to the base, which is as wide as apex of pronotum. Eyes of about 22 facets, occupying about one-sixth of side of head. Antennae nearly as long as head and pronotum; segments one to seven elongate, one longest and widest, more than twice as long as wide, two very little narrower, about twice as long as wide, three as long as two and very slender, little more than half as wide as two, four barely wider than three and twice as long as wide, five to ten increasing gradually in length and width, tenth about as long as wide, eleventh longer than wide, obconical. Temples not margined beneath the eyes. Pronotum a little wider than long, widest at apical third; sides arcuate from apex to near basal angles; basal angles slightly sinuate; base distinctly narrower than apex. Elytra almost as long as wide, conjointly as wide as pronotum. Abdomen inflated posteriorly; first three visible tergites deeply, fourth shallowly impressed at base; sixth sternite produced medially in a rounded triangular lobe with the apical margin slightly sinuate to the side. Lateral lobe of male genitalia slender, with the expanded tip produced at a little more than a right angle. Length 2.4 mm. Female unknown.

Type locality.—Descanso Bay, Baja California, Mexico.

Types.—Holotype, male, and 29 paratypes, apparently all males, from the type locality, on October 11, 1953.

Disposition of types.—The holotype and four paratypes deposited in the collection of the California Academy of Sciences. Two paratypes are

deposited with each of the following: San Diego Museum of Natural History; American Museum of Natural History; Museum of Comparative Zoology; Canadian National Collection; Chicago Natural History Museum; British Museum (Natural History); United States National Museum. The remaining paratypes are at present retained in my collection.

Additional material.—Thirteen specimens from La Jolla Shores, San Diego, California, in October and November, all taken in company with *D. harteri* under the same circumstances.

Remarks.—It is assumed that all the specimens taken are males because of the condition of the sixth sternite. The discovery of a single male of *D. harteri* disposes of the likelihood that the two species are opposite sexes of one species. *Megacephala* is distinct from all other species but *vandykei* by its very large, trapezoidal head. It can be distinguished from *vandykei* by the very long, slender third antennal segment and by the shorter elytra. The head varies in size from slightly larger than the pronotum to very much larger (as in the holotype). The holotype shows no intraorbital ridge but some other specimens have a trace of it basally. The color is about as variable as in *harteri*. The antennae are the most slender of the genus.

Diaulota vandykei, new species

Diaulota brevipes Chamberlin and Ferris, 1929, p. 155 (not *Amblopusa brevipes* Casey).

Description of male holotype.—Dark ferruginous, with elytra and outer antennal segments tinged with piceous; abdominal segments one to four and part of five dense-piceous; integuments minutely and densely granulose except on abdomen, which is densely reticulate; pubescence short, fine, and dense; puncturation fine and very dense, much denser on the abdomen than in *megacephala*. HEAD nearly round, very large, wider and longer than pronotum, about as wide as long, widest near the middle; sides evenly arcuate from behind the eyes to base, which is as wide as base of pronotum. Eyes of about 20 facets, occupying about one-eighth of side of head. Antennae about as long as head plus one-half of pronotum; segments one to three elongate, segment one more than twice as long as wide, two wider than one and very little longer than wide, three very little more than half as wide as two and distinctly shorter than two, a little longer than wide, four to six oval, increasing very gradually in size, seven to ten transverse, ten half again as wide as long, eleven elongate, obconical. Temples faintly margined beneath the eyes at base only. PRONOTUM very little wider than long, widest near apical third, sides arcuate from apex to base, base distinctly narrower than apex. Each ELYTRON a little longer than wide, elytra conjointly as wide as pronotum. ABDOMEN slightly inflated posteriorly, first

three visible tergites deeply, fourth shallowly impressed at base; sixth sternite produced medially in a rounded triangular lobe, sides not sinuate. Length 2.8 mm.

Allotype (female).—Similar to male but head smaller, about as wide as pronotum; sixth sternite rounded posteriorly.

Type locality.—Pacific Grove, Monterey County, California.

Types.—Holotype, male, allotype, female, and 25 paratypes (12 males and 13 females) taken at the type locality on November 24 and 28, 1954, and 10 paratypes (5 males and 5 females) taken at Pigeon Point, San Mateo County, California, on November 25, 1954. All specimens were collected from cracks in the rocks in company with *Diaulota densissima* and *Liparocephalus cordicollis* at or near the +3 to +4 foot tide level on the exposed reefs. The specimens were all taken just above the line of dense seaweed, as no suitable place to search for them could be found below this mark.

Disposition of types.—The holotype, allotype, and four paratypes deposited in the collection of the California Academy of Sciences. Two paratypes are deposited with each of the following: San Diego Museum of Natural History; American Museum of Natural History; Museum of Comparative Zoology; Canadian National Collection; Chicago Natural History Museum; British Museum (Natural History); United States National Museum. The remaining paratypes are at present retained in my collection.

Additional material.—More than 100 specimens, males, females and larvae, of this species (or one which is very similar) were taken from the reef at about +2 tide level at Shell Beach, San Luis Obispo County, California. This series is quite variable in the shape and size of the head of the male and is much lighter in color than the type series. The abdominal punctuation is not quite so dense, particularly beneath. However, I am unable to find any consistent character that will separate the two series with certainty. The antennae, the secondary sexual characters, and other characters are very similar.

Remarks.—This species is more likely to be confused with *megacephala* than with any other. It can readily be separated from that species by the very thick second antennal segment and by the much shorter and stouter third antennal segment, as well as by the longer elytra. This is the species that Chamberlin and Ferris identified as *Amblopusa brevipes* Casey, an identification that led them to synonomize the two genera. It differs from that species, however, in many fundamental structural characters, as explained in the remarks following the description of *Amblopusa*. This species is named in memory of the late Edwin C. Van Dyke.

AMBLOPUSA Casey

Amblopusa Casey, 1893, p. 355; Fenyes, 1918, p. 104.
Amblyopusa Eichelbaum, 1909, p. 209 (emendation).

Generitype.—*Amblopusa brevipes* Casey.

Diagnosis.—Body elongate, parallel, depressed. Head ovoid. Labrum rounded. Mandibles symmetrical, with 2 or 3 serrations between median tooth and tip; not curved ventrally at tip. Mentum emarginate, the emargination flat at bottom. Maxillary palpi with third segment distinctly ovoid, fourth long and slender. Inner lobe of maxilla slender, with a long blunt tooth at tip, 3 or 4 shorter teeth close to the tip, and 2 larger median teeth well separated from each other; outer lobe slender with a brush of long setae at the tip and another toward the middle. Labial palpi distinctly three-segmented; basal segment twice as long as wide; second a little narrower than first, a little longer than wide; third narrower than second and as long as first, four times as long as wide. Ligula simple, a little longer than first segment of labial palpi, truncate at tip. Eyes minute, with from 3 to 18 facets. Antennae with first two segments elongate, third to seventh slightly elongate, eighth to tenth ovoid. Pronotum faintly impressed longitudinally. Anterior margin of prosternum straight. Elytra more than half as long as pronotum. Tibiae pubescent. Anterior tarsi short and compact. Abdomen with first five tergites impressed at base; first four sternites constricted at base.

Remarks.—Chamberlin and Ferris stated that in their opinion, based on the identification of the species at hand, *Amblopusa* is congeneric with *Diaulota.* Examination of specimens of *Amblopusa brevipes* from British Columbia reveals that the specimens which they identified as that species were actually *Diaulota vandykei,* described here. It is my opinion that the two genera are quite distinct from one another. *Amblopusa* differs from *Diaulota* in many characters, including the very small eyes, the structure of the labial palpi (Casey's specimen obviously had the last segments missing), the serrate mandibles, the longer elytra, the longer metasternum, the structure of the maxillae, the impressed fourth and fifth tergites and the constricted sternites. Casey had described three species of *Amblopusa,* one of which, *A. pallida,* has been reduced to a synonym of *A. brevipes* by Fenyes. The two species appear to be quite similar but probably are distinct.

KEY TO THE SPECIES OF AMBLOPUSA CASEY

A. Eyes of 3 to 5 facets, elytra three fourths as long as pronotum . . . . . *brevipes*
AA. Eyes of 12 to 18 facets, elytra two-thirds as long as pronotum . . . . . *borealis*

Amblopusa brevipes Casey

Amblopusa brevipes Casey, 1893, p. 356 (not Chamberlin and Ferris, 1929).
Amblopusa pallida Casey, 1911, p. 212.

Description.—Ferruginous, with the legs paler; integuments very minutely and densely granulose, except on abdomen, which is very minutely reticulate, shining; pubescence moderately long and fine, rather sparse, particularly on the abdomen; puncturation fine, not dense, more noticeable on the elytra. Head oval, very little wider than pronotum, a little longer than wide, widest near basal third, sides evenly arcuate. Eyes minute, of 3 to 5 facets, near the insertion of the mandibles. Pronotum roughly trapezoidal, a little longer than wide, with sides rounded at the anterior fifth which is the widest point, and thence nearly straight to the obtuse basal angles; base and apex both arcuate; base narrower than apex. Elytra conjointly nearly square, not quite as wide as pronotum and about three-fourths as long, outer edges slightly arcuate, particularly at the humeral angles. Abdomen nearly parallel, as wide as pronotum; first five visible tergites strongly impressed at base; first four sternites somewhat constricted at base. Male with sixth sternite produced medially in a very short broad rounded triangular lobe. Female with sixth sternite rounded. Length 2.4 mm.

Type locality.—Fort Wrangel, Alaska.

Additional published record.—Metlakatla, "British Columbia" [Metlakatla is in Alaska].

Material examined.—I have seen 4 specimens from Massett, British Columbia, and 1 from Fort Wrangel, Alaska, all in the Fenyes collection (C.A.S.). The last specimen is labeled "Dupl. No. 131 Casey 1891."

Remarks.—This species differs from *A. borealis* in the smaller eyes and longer elytra. A previous record of this species from Moss Beach, California, was based on *Diaulota vandykei.*

Amblopusa borealis Casey

Amblopusa borealis Casey, 1906, p. 354.

Description.—Ferruginous; the abdomen sometimes partially piceous; integuments very minutely and densely granulose except on abdomen, which is very minutely reticulate, shining; pubescence moderately long and fine, rather sparse, particularly on the abdomen; puncturation fine, not dense, most noticeable on the elytra. Head round, wider than pronotum, widest near the middle; vertex nearly flat; eyes of 12 to 18 facets located at anterior fourth. Pronotum roughly trapezoidal, a little longer than wide;

sides rounded at anterior fifth, which is the widest point, and thence nearly straight, but slightly sinuate just before the obtuse basal angles; base and apex both arcuate; base narrower than apex. ELYTRA conjointly wider than long; two-thirds as long as pronotum; apex very little wider than base; sides slightly arcuate, particularly at the humeral angles. ABDOMEN nearly parallel, as wide as pronotum; first five visible tergites strongly impressed at base; first four sternites strongly constricted at base. MALE with sixth sternite produced medially in a short broad roaded triangular lobe. FEMALE with sixth sternite rounded. LENGTH 3.3 mm.

Type locality.—Massett, Queen Charlotte Island, British Columbia.

Recorded distribution.—Metlakatla, "British Columbia" [Metlakatla is in Alaska].

Material examined.—I have seen 6 specimens from Massett, Queen Charlotte Island, British Columbia, and 1 collected by E. C. Van Dyke at Dutch Harbor, Unalaska, Alaska. These are in the Fenyes collection (C.A.S.). I collected 2 specimens at Pacific Grove, Monterey County, California, in November, in company with *Diaulota vandykei, D. densissima,* and *Liparocephalus cordicollis.*

Remarks.—Differs from *brevipes* in the larger eyes and shorter elytra, as well as in the shape and size of the head.

BRYOBIOTA Casey

Bryobiota Casey, 1893, p. 367; Fenyes, 1920, p. 130.

Generitype.—*Bryobiota bicolor* (Casey).

Diagnosis.—Body elongate, parallel, subdepressed. Head subquadrate, deeply impressed longitudinally along the midline, particularly at the base. Labrum truncate. Mandibles asymmetrical, left simple, right with a small blunt median tooth, not curved ventrally at tip. Mentum broadly, shallowly, arcuately emarginate. Third segment of maxillary palpi oval; fourth narrow, elongate. Inner lobe of maxillae spinose apically with a setose membranous expansion at base; outer lobe one-fourth as broad as long, with an expanded membranous ball at tip. Labial palpi three-segmented; basal segment twice as long as wide, second a little narrower and two-thirds as long, third half as wide as first and as long as second. Ligula simple, narrow, as long as basal segment of labial palpus. Eyes very small, occupying less than one-fifth of side of head. Antennae with first five segments elongate, tenth slightly transverse. Pronotum ovoid. Anterior margin of prosternum

slightly arcuate anteriorly. Elytra as long as pronotum. Tibiae pubescent. Posterior tarsi with basal segment longer than second. Abdomen with first four tergites impressed at base; first four sternites constricted at base.

Remarks.—This genus shares a number of characters with *Antarctophytosus* and with *Amblopusa*. It is easily recognized by the longitudinal impression of the head and pronotum as well as by the rather quadrate head. The generitype is the only species known.

Bryobiota bicolor (Casey)

Phytosus bicolor Casey, 1885, p. 311.
Bryobiota bicolor (Casey), 1893, p. 368.

Description.—Ferruginous, with the first five abdominal segments black; integuments very finely granulose, shining; pubescence short, moderately sparse; moderately shallowly punctured throughout. Head a very little wider than pronotum, subquadrate; sides nearly straight and nearly parallel from the eyes to a sharply rounded hind angle, thence almost straight in to the neck, which is half as wide as head. Head barely widest at hind angle; divided longitudinally by a rather strong impression which is deepest posteriorly, giving on the dorsal posterior surface the appearance of low mound-like elevations. Eyes small, inserted at the anterior angles of the head. Pronotum ovoid, a little longer than wide, widest near anterior third; sides arcuate; hind angles not sinuate; anterior and posterior margins evenly, gently arcuate; base narrower than apex. Elytra a little wider and about as long as pronotum, conjointly about as wide as long; sides evenly arcuate; apices nearly straight; hind angles hardly rounded. Abdomen nearly parallel but with fifth segment the widest; 4 tergites impressed at base, impressions strong. No sexual differences have been observed. Length about 2.4 mm.

Type locality.—San Diego, California.

Additional published records.—San Diego, California. Scheerpeltz, 1934, p. 1557, gave British Columbia as a locality record without citation to any authority. I am unable to locate this record.

Material examined.—Seven specimens from San Diego County, California, collected by Blaisdell (C.A.S.); 1 from San Diego, California, A. Fenyes (Brit. Mus.); 5 from San Diego, California, Fenyes (C.A.S.); 1 taken by myself at San Diego, California; 1 from Moss Beach, San Mateo County, California, by J. O. Martin (C.A.S.).

Remarks.—In 1885 Casey appended the following note to his description of the species. "This species is extremely abundant under the densely

packed seaweed thrown up on the shores of the inner harbor in the spring of the year; occurring with it and also in great abundance, were *Cafius (Remus) decipiens Lec., Motschulskium sinuaticolle Matth., and Phycocoetes testaceus* Lec., and in less number, *Cafius (Remus) opacus* Lec." I have collected in the area of San Diego Bay for many years and have never seen masses of seaweed cast up on the shores of the inner harbor. I have never taken *Cafius decipiens* LeConte, only one specimen of *Cafius opacus* LeConte, and only one specimen of *Bryobiota bicolor* (Casey). The conditions in the bay are so changed since 1885 that it is unlikely that these species will ever be found there in abundance again.

BRYOTHINUSA Casey

Bryothinusa Casey, 1904, p. 312; Fenyes, 1920, p. 131.

Generitype.—*Bryothinusa catalinae* Casey.

Diagnosis.—Body elongate, parallel, depressed. Head oval, shallowly concave centrally. Labrum transverse, with anterior margin gently arcuate. Mandibles asymmetrical, the right with a median tooth and with very minute serrations between the median tooth and tip, the left simple; not curved ventrally. Mentum broadly trapezoidal, truncate. Second and third segments of maxillary palpi ovoid, fourth shorter than width of third. Inner lobe of maxillae slender, acutely pointed and hooked at tip with a row of evenly placed, short, stout, pointed setae at inner margin; outer lobe as long as inner, very slender, particularly at apical fourth, with tip hooked and finely pointed, and inner edge simple. Labial palpi either two- or three-segmented; when three-segmented, first segment shorter than second and wider only at base, and third segment narrower than second and a little longer than first. Ligula short, no longer than width of basal segment of labial palpus; simple. Eyes small, occupying about one-fourth of side of head; composed of about 20 facets interspersed with short hairs. Antennae long, with all segments elongate; first segment widest, third narrowest and a little longer than wide, the remainder each a little longer and a little wider than the preceding, the tenth distinctly elongate, eleventh more than twice as long as wide and gradually pointed at apex, nearly equal to first in size. Pronotum transverse, quadrate, widest at apical fifth. Anterior margin of prosternum slightly emarginate in a gentle arc. Elytra about as long and as wide as pronotum, longest at outer edge. Tibiae pubescent. Posterior tarsi with basal segment longer than second. Abdominal segments not impressed at base; sternites not constricted.

Remarks.—*Bryothinusa* is at once distinguished from all other phyto-

sids by the very elongate antennal segments and the very slender, curved, simple outer lobe of the maxillae. Only one species is known, the generitype.

This genus would be placed in the Myllaenini by those following present classification, but it probably is not closely related to members of that tribe. It may be closely related to *Polypea* Fauvel, which, as has already been pointed out, was placed in the Myllaenini by Bernhauer and Scheerpeltz and in the Phytosi by Fenyes. It appears to be the most discordant element in the present group.

Bryothinusa catalinae Casey

Bryothinusa catalinae Casey, 1904, p. 312.

Description.—Fulvous, with abdomen slightly darker; integuments clothed in a dense short pubescence; finely, densely punctate, the abdomen with a network of fine lines around the punctures. Head nearly round, vertex broadly concave. Pronotum subquadrate, widest at anterior third, sides evenly arcuate, base slightly narrower than apex. Elytra about as wide and about as long as pronotum; apex slightly sinuate at outer angle. Abdomen nearly parallel. No sexual differences observed. Length about 2.0 mm.

Type locality.—Catalina Island, California.

Recorded distribution.—Catalina Island, California.

Material examined.—I have seen 2 specimens in the Fenyes collection from Catalina Island, California, one collected by Fall and the other by Baker, as well as 2 specimens from San Diego, California, in the Fenyes collection (C.A.S.). Nine specimens were taken together from a crack in a large wet stone near high tide mark on a stony beach at La Jolla, California, in September, 1953. They were much more agile than any other phytosids collected by me, running rapidly downward when the stone was split open. I believe that several of the colony escaped. Two of these specimens were kindly compared with Casey's type by R. E. Blackwelder.

THINUSA Casey

Thinusa Casey, 1893, p. 371; Fenyes, 1920, p. 134.

Generitype.—*Thinusa maritima* (Casey).

Diagnosis.—Body elongate, parallel, somewhat depressed. Head oval, slightly pointed anteriorly. Labrum bilobed, with the central emargination filled with a dark, depressed membrane. Mandibles curved ventrally at tip; right mandible with a median tooth, left simple. Mentum truncate. Maxillary palpi with third segment evenly conical, narrow, widest at apex; fourth

segment very slender, and longer than in *Phytosus*. Inner lobe of maxillae spinose internally, with a membranous expansion at the base through which run several long spines; outer lobe with a membranous finger-like process at tip. Labial palpi three-segmented, the basal segment longest, second shortest; segments decreasing in width apically. Ligula deeply bifid, the two processes forming a Y; half as long as first segment of labial palpi. Eyes large, occupying more than one-half the side of head. Antennae with first 3 segments elongate, sixth to tenth transverse, eleventh with a brush of short setae at tip. Anterior margin of prosternum straight. Elytra extending more posteriorly at the sides than at the suture, so that the apex, although straight, is oblique. Anterior and middle tibiae externally with long spines, which are interspersed with pubescence. Posterior tarsi with first segment variable, either shorter, equal to or longer than second but never longer than second and third together. Abdomen with either 3 or 4 segments impressed at base; sternites not constricted.

Remarks.—Casey stated that *Thinusa* so closely resembles *Actosus* that it might be considered a subgenus of it. He apparently did not observe the bifid ligula, by which it differs from all other phytosids except *Cameronium*. Besides the spinose tibiae, *Thinusa* resembles *Phytosus* in the form of the maxillae and in the pubescence on the pronotum, which streams out laterally from the mid-line in a most striking manner. It is an interesting and puzzling fact that several very abundant species of the tribe Myrmedoniini which are found in the seaweed in association with *Thinusa* so closely resemble it in many structural characters (i.e. the spinose tibiae, the arrangement of the pubescence; the shape of head and size of eyes, the structure of the mouth parts) that it is a great task to collect *Thinusa* and to segregate the few specimens from their many cousins. The similarities are so great as to make one wonder about our tarsal system of classification which separates these forms so widely.

Of the 6 species of *Thinusa* that Casey described from California, Fenyes considered only *maritima* and *fletcheri* valid. One of the main characters mentioned by Casey for the separation of the species was the relative length of the basal segment of the posterior tarsi. According to Fenyes' synonomy, this character would be variable intraspecifically. All the specimens examined by me have the first tarsal segment a little longer than the second; but, because of the overlapping structure of the segments, the first may appear shorter if viewed other than directly from the side. Casey's original description of *maritima* states that the first and second segments are equal; but following his description of *obscura* he states that the first segment of that species is longer, not shorter, than the second, as in *maritima*.

I believe the synonomy given by Fenyes to be correct. The rather good series I have seen from various localities indicates that there is considerable variations in the characters chosen by Casey. Even *fletcheri* and *maritima* are difficult to separate with certainty and future studies may show that the former is merely a geographic race of *maritima*.

KEY TO THE SPECIES OF THINUSA CASEY

A. Abdomen shining, very finely reticulate ..... *maritima*
AA. Abdomen dull, densely granulose ..... *fletcheri*

Thinusa maritima (Casey)

Phytosus maritimus Casey, 1885, p. 312.
Thinusa maritima Casey, 1893, p. 371.
Thinusa obscura Casey, 1906, p. 354.

Description.—Ferruginous, head brown; abdomen sometimes piceous; integuments densely and finely granulose, except on abdomen, which is finely reticulate; clothed in a moderately long, even, pale pubescence, which is sparse on the abdomen; moderately punctured throughout. Head about as wide as long, pointed anteriorly, widest just behind the large eyes. Antennae not as long as head and pronotum. Pronotum widest at anterior third, sides arcuate in front and straighter to the slightly rounded posterior angles. Elytra three-fourths as long as pronotum at sides, two-thirds as long at suture, conjointly not as wide as pronotum. Abdomen narrower than pronotum; sides straight and nearly parallel. No sexual differences observed. Length 2.4 mm.

Type locality.—Oakland, Alameda County, California.

Additional published records.—Santa Barbara, Santa Barbara County, California (as *T. obscura* Casey). This species was reported from four localities in New Jersey by Morse, 1909, but I believe on the basis of a misidentification, or, more likely, on an error in transcription, as it is listed as "Thinusa maritima Casey (Polystoma)."

Material examined.—One specimen from Ilwaco, Washington, collected by Hubbard and Schwarz (Fenyes collection, C.A.S.); 6 collected in May at San Francisco, California, by Blaisdell (C.A.S.); 15 from Rockaway Beach, San Mateo County, California, in October (Ian Moore); 6 from Redondo Beach, Los Angeles County, California, by Fenyes (5 C.A.S.; 1 Brit. Mus.); 3 from Balboa, Orange County, California (Fenyes, C.A.S.); 5 from La Jolla in San Diego, California, in November (Ian Moore).

Remarks.—If *obscura* is actually distinct from *maritima,* the above specimens must all be the former and *maritima* not seen by me. There is considerable variation in color, in shape and size of the antennal segments, particularly the eleventh, and in some other characters.

Thinusa fletcheri Casey

Thinusa fletcheri Casey, 1906, p. 353.
Thinusa divergens Casey, 1911, p. 213.
Thinusa nigra Casey, 1911, p. 214.
Thinusa robustula Casey, 1911, p. 214.

Description.—Dark brown, with abdomen piceous; integuments densely granulose throughout; clothed in a moderately long, pale pubescence which is sparser on the abdomen; moderately punctured throughout. HEAD a little wider than long, hardly pointed in front, widest just behind the eyes; antennae not as long as head and pronotum. PRONOTUM a little wider than long, widest at anterior third, sides arcuate anteriorly and slightly sinuate before the hind angles. ELYTRA two-thirds as long as pronotum, a little longer at the sides. ABDOMEN parallel, almost as wide as pronotum. No SEXUAL DIFFERENCES observed. LENGTH 3.0 mm.

Type locality.—Massett, Queen Charlotte Island, British Columbia.

Recorded distribution.—British Columbia.

Material examined.—I have seen 2 specimens from the type locality (Fenyes collection, C.A.S.) and 3 from Nazan Bay, Atka, Aleutians, Alaska, collected by E. C. Van Dyke in August (Fenyes collection, C.A.S.).

Remarks.—Although this may eventually prove to be only a geographic race of *maritima,* the specimens examined are quite noticeably larger, stouter, darker, and with a duller, more strongly granulose surface. I can find no other consistent characters to separate the species.

PHYTOSUS Curtis

Phytosus Curtis, 1838, pl. 718; Erichson, 1840, p. 177; Kraatz, 1853, p. 257, t. 3; Kraatz, 1856, p. 41; Kraatz, 1857, t. 1; Jacquelin DuVal, 1856, p. 5, pl. 3; Fauvel, 1862, p. 82; Thomson, 1859, p. 207; Mulsant and Rey, 1872, p. 381; Ganglbauer, 1895, p. 285; Fenyes, 1920, p. 131; Bernhauer, 1941, p. 96.
Paraphytosus Bernhauer, 1922, p. 236 (not Cameron, 1917).
Phytosus Kiessenwetter, 1850, p. 385.
Subgenus *Actosus* Mulsant and Rey, 1872, p. 391.
Subgenus *Euphytosus* Bernhauer and Scheerpeltz, 1926, p. 552.
Subgenus *Anopsisus* Bernhauer, 1929, p. 187.

Generitypes.—of *Phytosus, Phytosus spinifer* Curtis; of *Actosus, Actosus nigriventris* (Chevrolat); of *Euphytosus, Euphytosus schenklingi* (Bernhauer); of *Anopsisus, Anopsisus microphthalmus* Bernhauer.

Diagnosis.—Body elongate, parallel, somewhat depressed. Head oval. Labrum variable, truncate or slightly emarginate. Mandibles each with a median tooth, with the tip curved ventrally. Mentum truncate. Maxillary palpi with second segment ovoid, larger than first. Outer lobe of maxillae with a membranous finger-like process at tip; inner lobe setose internally at apex. Labial palpi distinctly three-segmented; the segments of about equal length; the last segment narrowest. Ligula simple, slender, little more than half as long as first segment of labial palpi. Eyes moderate in size, but less than one-half the length of side of head. Antennae with first three segments elongate, seventh to tenth transverse, eleventh elongate obconical. Anterior margin of prosternum straight. Anterior and middle tibiae with several series of long thick setae externally which are interspersed with the pubescence. Elytra in *P. spinifer* longest observed in the subtribe, considerably longer than pronotum; in *nigriventris* not as long as pronotum. Abdomen with first four tergites impressed at base; first four sternites constricted at base.

Remarks.—The diagnosis is based entirely on *Phytosus (Phytosus) spinifer* Curtis, the generitype, *Phytosus (Actosus) nigriventris* (Chevrolat), and *Phytosus (Actosus) balticus* Kraatz. *Phytosus,* the first genus described in the subtribe, has been a catch-all for numerous doubtful seashore species, some of which were later removed to other genera. There still remain in the genus several species which will have to be re-examined before an adequate diagnosis of the genus can be given. I have seen too few of the species listed for the genus to be able to give it a satisfactory evaluation. The descriptions of most of these species are inadequate. To judge from the descriptions, two of the subgenera, *Anopsisus* Bernhauer and *Euphytosus* Bernhauer and Scheerpeltz (= *Paraphytosus* Bernhauer, not Cameron), probably do not belong here. The former, according to Koch, is probably a *Diglotta.* The latter probably does not belong to this subtribe either.

Material examined.—*Phytosus spinifer* Curtis: 16 specimens from France (Fenyes, C.A.S.), 1 from Spain (Fenyes, C.A.S.), 1 from Crete (Fenyes, C.A.S.), 1 from Senegal (Brit. Mus.), 3 from the Canary Islands, labeled *P. dimidiatus* Wollaston (Brit. Mus.) and 2 which appear to be this species labeled "*Phytosus littoralis* Horn" from "Gaudel I." (Fenyes C.A.S.). *Phytosus nigriventris* (Chevrolat): 9 from France (Fenyes, C.A.S.). *Phytosus balticus* Kraatz: 5 from France, 1 from Crete and 2 from Tunis (Fenyes, C.A.S.). *Phytosus fenyesi* Bernhauer: one specimen in very poor condition from Senegal, identified by Bernhauer (Fenyes, C.A.S.).

CAMERONIUM Koch

Cameronium Koch, 1936, p. 202.

Generitype.—Cameronium obockianum (Fauvel).

Diagnosis.—Body elongate, parallel, subdepressed. Head oval. Infraorbital ridge entire. Labrum rounded at apex. Mandibles not curved ventrally; simple. Third segment of maxillary palpi oval; fourth narrow, short. Inner lobe of maxillae with fine, evenly spaced, internal spines at apical half and a group of long setae at base; outer lobe a little longer than inner with a brush of setae at tip. Labial palpi apparently two-segmented. Ligula short, bifid at tip in the form of a blunt Y. Eyes not prominent, occupying a little less than half the side of head, with setae between the facets. Antennae with first three segments elongate, tenth transverse. Pronotum quadrate. Elytra conjointly nearly square, a little wider and considerably longer than pronotum. Tibiae pubescent with three or four very short, stout setae on the anterior pair. Posterior tarsus with the first four segments subequal, fifth as long as the preceding two together. Abdomen with the first three tergites impressed at base, the first three sternites faintly constricted.

Remarks.—The type species was originally described as a *Phytosus* which it resembles rather closely, but differs in the lack of long spines on the front and middle tibiae. The bifid ligula it shares with *Thinusa*, which, however, has spinose tibiae. My description of the inner and outer lobes of the maxillae differs somewhat from the figure given by Koch. These parts, often difficult to see, were very clearly visible on one specimen I examined.

Material examined.—I have seen seven specimens of *Cameronium obockianum* (Fauvel) from the type locality, Perim, at the mouth of the Red Sea, collected by Fauvel (Fenyes Coll., C.A.S.). Another species, *C. flavipenne* Cam. which was described from Zanzibar is said to be smaller, more shining and differently colored.

BAEOSTETHUS Broun

Baeostethus Broun, 1909, p. 96; Fenyes, 1920, p. 130.

Generitype.—Baeostethus chiltoni Broun.

No specimens of this genus have been seen, so the original description is repeated here. Only one species, the generitype, is known.

"Body very elongate. HEAD subrotundate, with a short narrow muzzle. THORAX cordate-quadrate. ELYTRA very short. HIND-BODY very elongate. EYES minute. MENTUM very large, slightly emarginate in front. Labial

palpi rather short; basal 2 joints cylindric, equally elongate; 3rd slender and nearly the length of the penultimate. Maxillary palpi setose; basal joint small; 2nd stout and elongate, gradually thickened; 3rd inserted at apex of the preceding one but so as to be at a right angle to it, rather longer than 2nd, gradually incrassate towards and truncate at the apex; 4th joint small, aciculate. Mandibles stout, rather short, acutely curvate at the extremity, with 3 inner teeth. Antennae inserted at the sides of the forehead, in front of the eyes; basal 3 joints stout and elongate, narrowed towards the base; 2nd articulation a little shorter than 1st, but slightly longer than 3rd; 4th oblong; 5th and 6th oviform; 7th and 8th slightly broader than preceding one; 9th and 10th subquadrate; 11th oblong-oval. Tarsi filiform, the posterior pentamerous, intermediate quadriarticulate, the anterior seemingly also 4-jointed but so short and compact and thickly setose that the basal joints cannot be distinguished separately. Claws elongate, simple. All the coxae elongate, prominent, and contiguous. Prosternum corneous across the middle, membranous elsewhere. The ligula appears to be simple and aciculate.

"Notwithstanding the elongation of the body, the metasternum is so excessively reduced that the intermediate and posterior coxae are in actual contact. This character of itself is distinctive.

"*Baeostethus chiltoni*, sp. nov.

"*Subopaque*, finely pubescent; head and elytra obscure infuscate red; thorax, legs and antennae fusco-testaceous; hind-body fuscous or nigrescent, the segments with a short pallid basal membrane. Head broadly rounded, somewhat depressed on the middle, closely and very minutely punctate, with 2 small indistinct median foveae. Forehead rather abruptly narrowed, short, medially convex, nearly smooth and shining, with a setigerous fovea at each side, truncate and with a short grey membrane in front. Labrum prominent, rounded and bearing fine yellow setae in front. Eyes minute, situated at the sides in front, depressed, hardly discernible. There is no neck. Thorax widest in front, gradually narrowed backwards; base truncate, apex feebly and broadly curvate; it is without definite lateral margins; the angles are nearly rectangular; there is a feebly median impression behind; its surface is finely and closely punctured, and bears slender greyish and infuscate pubescence. Scutellum large and broad. Elytra abbreviated, shorter than thorax, each strongly rounded and finely margined at the base so as to be oblique towards the suture, apices subtruncate yet almost oblique inwardly, their sides curvedly narrowed towards the base; their surface dull, the sculpture concealed by the pubescence, but consist-

ing apparently of very minute distant granules. HIND-BODY very elongate, broadly marginated, the basal 5 segments transversal, each however becoming rather longer than its predecessor, 6th with short styles, 7th narrow and testaceous, all finely and moderately closely punctured and pubescent. LEGS slender. FEMORA and TIBIAE ciliated with fine greyish setae.

"Length, 2½ lines; breadth, quite ⅜ line.

"Campbell Island.

"Named in honour of Professor Chilton, to whom we are indebted for the discovery of this and some other species."

Judging from the above description, this genus would appear to resemble *Amblopusa* in most characters except for the very short metasternum (a character which it shares with *Diaulota* and *Liparocephalus)* and the densely setose anterior tarsae. The mention of three internal teeth on the mandible could be interpreted to mean the same as serrations between the median tooth and the tip, particularly if only the end of the mandible was visible in the specimen examined. No mention is made of dorsal impressions on the tergites.

ANTARCTOPHYTOSUS Enderlein

Antarctophytosus Enderlein, 1909, p. 377; Fenyes, 1918, p. 105.
Paraphytosus Cameron, 1917, p. 125.
Austromalota Brèthes, 1925, p. 170.

Generitype.—Antarctophytosus atriceps (Waterhouse).

Diagnosis.—Body elongate, subparallel, depressed. Head oval; the clypeal area depressed on each side but not on the midline, so that there is a broadly triangular raised area with its apex at the anterior margin of the head and its base just anterior to the anterior margins of the eyes. Infraorbital ridge very strong. Labrum broadly rounded. Mandibles not curved ventrally; asymmetrical, the left simple, the right with a very short median tooth. Mentum rather deeply, arcuately emarginate in its central two thirds. Third segment of maxillary palpi slightly ovoid; fourth narrow, elongate. Inner lobe of maxillae spinose internally. Labial palpi two- or three-segmented, first a little longer than wide, second as wide as first and twice as long, third narrower than second and nearly as long. Ligula, slender, simple; twice as long as first segment of labial palpi. Eyes flat, not interrupting the contour of head; large, occupying more than one-third of the side of head. Antennae with the first three segments elongate, third shorter than second, segments nine and ten transverse. Pronotum ovoid; widest at anterior fourth; sides evenly arcuate; hind angles broadly rounded into the arcuate

base. Anterior margin of prosternum bisinuate. Elytra about as long and as wide as pronotum; apices emarginate at outer angle. Tibiae setose. Posterior tarsi with first four segments subequal, fifth as long as preceding two together. Abdomen with first four tergites impressed at base; sternites not constricted.

Remarks.—Rather closely resembles *Bryobiota* in many characters but not in appearance. Can be distinguished at once from *Bryobiota* by the evenly convex dorsal surface of the basal half of the head.

Material examined.—I have seen 2 specimens of *A. atriceps* (Waterhouse), 1 from Kerguelen Island in the Antarctic-Indian Ocean determined by Jeannel and 1 from Cape of Good Hope; a specimen of *A. darwini* Waterhouse from the Faulkland Islands, determined by Dr. Cameron, and two specimens of *A. darwini* from the Faulkland Islands (in the Fenyes collection). I am unable to distinguish between the two species.

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Explanation of Figures

Plate 8

Figure 1. *Liparocephalus brevipennis* Mäklin, apical margin of labrum.
Figure 2. *Liparocephalus brevipennis* Mäklin, labial palpi and ligula.
Figure 3. *Liparocephalus brevipennis* Mäklin, apical margin of mentum.
Figure 4. *Liparocephalus brevipennis* Mäklin, outline of the body of female, dorsal view.
Figure 5. *Liparocephalus cordicollis* LeConte, apical margin of labrum.
Figure 6. *Liparocephalus cordicollis* LeConte, labial palpi and ligula.
Figure 7. *Liparocephalus cordicollis* LeConte, apical margin of mentum.
Figure 8. *Liparocephalus cordicollis* LeConte, maxilla.
Figure 9. *Liparocephalus cordicollis* LeConte, outline of body of male, dorsal view.
Figure 10. *Dianlota densissima* Casey, apical margin of labrum.
Figure 11. *Dianlota densissima* Casey, labial palpi.
Figure 12. *Dianlota densissima* Casey, apical margin of mentum.
Figure 13. *Dianlota densissima* Casey, apex of abdomen of male, ventral view.
Figure 14. *Dianlota densissima* Casey, outline of body of female, dorsal view.
Figure 15. *Dianlota fulviventris* Moore, apical margin of labrum, male.
Figure 16. *Dianlota fulviventris* Moore, apical margin of mentum, male.
Figure 17. *Dianlota fulviventris* Moore, apex of abdomen of male, ventral view.
Figure 18. *Dianlota fulviventris* Moore, apex of abdomen of male with genitalia extruded, lateral view.
Figure 19. *Dianlota fulviventris* Moore, labial palpi, male.
Figure 20. *Dianlota fulviventris* Moore, labial palpi, male.

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Figure 21. *Dianlota fulviventris* Moore, apical margin of labrum, female.
Figure 22. *Dianlota fulviventris* Moore, labial palpi, female.

Figure 23. *Diaulota fulviventris* Moore, apical margin of mentum, female.
Figure 24. *Diaulota fulviventris* Moore, maxilla.
Figure 25. *Diaulota fulviventris* Moore, outline of body of female, dorsal view.
Figure 26. *Diaulota harteri* Moore, anterior margin of labrum.
Figure 27. *Diaulota harteri* Moore, labial palpi.
Figure 28. *Diaulota harteri* Moore, apical margin of mentum.
Figure 29. *Diaulota harteri* Moore, apex of abdomen of male, ventral view.
Figure 30. *Diaulota harteri* Moore, apex of abdomen of female, ventral view.
Figure 31. *Diaulota harteri* Moore, outline of body of female, dorsal view.
Figure 32. *Diaulota megacephala* Moore, apex of labrum.
Figure 33. *Diaulota megacephala* Moore, labial palpi and ligula.
Figure 34. *Diaulota megacephala* Moore, apex of mentum.
Figure 35. *Diaulota megacephala* Moore, apex of abdomen of male, ventral view.
Figure 36. *Diaulota megacephala* Moore, lateral lobe of male genitalia.
Figure 37. *Diaulota megacephala* Moore, first three antennal segments.
Figure 38. *Diaulota megacephala* Moore, outline of body of male, dorsal view.
Figure 39. *Diaulota vandykei* Moore, apical margin of labrum.
Figure 40. *Diaulota vandykei* Moore, labial palpi.
Figure 41. *Diaulota vandykei* Moore, apical margin of mentum.
Figure 42. *Diaulota vandykei* Moore, apex of abdomen of male, ventral view.
Figure 43. *Diaulota vandykei* Moore, first three antennal segments.
Figure 44. *Diaulota vandykei* Moore, outline of body of male, dorsal view.

Plate 10

Figure 45. *Amblopusa brevipes* Casey, apical margin of labrum.
Figure 46. *Amblopusa brevipes* Casey, apical margin of mentum.
Figure 47. *Amblopusa brevipes* Casey, labial palpi and ligula.
Figure 48. *Amblopusa brevipes* Casey, apical margin of sixth sternite of male.
Figure 49. *Amblopusa brevipes* Casey, outline of body, dorsal view.
Figure 50. *Amblopusa borealis* Casey, apical margin of labrum.
Figure 51. *Amblopusa borealis* Casey, labial palpi and ligula.
Figure 52. *Amblopusa borealis* Casey, inner and outer lobes of maxilla.

Figure 53. *Amblopusa borealis* Casey, apical margin of sixth sternite of male.
Figure 54. *Amblopusa borealis* Casey, outline of body, dorsal view.
Figure 55. *Bryobiota bicolor* (Casey), apical margin of labrum.
Figure 56. *Bryobiota bicolor* (Casey), labial palpi and ligula.
Figure 57. *Bryobiota bicolor* (Casey), apical margin of mentum.
Figure 58. *Bryobiota bicolor* (Casey), inner and outer lobes of maxilla.
Figure 59. *Bryobiota bicolor* (Casey), outline of body, dorsal view.
Figure 60. *Bryothinusa catalinae* Casey, apical margin of labrum.
Figure 61. *Bryothinusa catalinae* Casey, labial palpi and ligula.
Figure 62. *Bryothinusa catalinae* Casey, apical margin of mentum.
Figure 63. *Bryothinusa catalinae* Casey, ends of mandibles.
Figure 64. *Bryothinusa catalinae* Casey, ends of outer and inner lobes of maxilla.
Figure 65. *Bryothinusa catalinae* Casey, outline of body, dorsal view.

PLATE 11

Figure 66. *Thinusa maritima* (Casey), apical margin of labrum.
Figure 67. *Thinusa maritima* (Casey), labial palpi and ligula.
Figure 68. *Thinusa maritima* (Casey), apical margin of mentum.
Figure 69. *Thinusa maritima* (Casey), maxilla.
Figure 70. *Thinusa maritima* (Casey), outline of body, dorsal view.
Figure 71. *Phytosus (Phytosus) spinifer* Curtis, apical margin of labrum.
Figure 72. *Phytosus (Phytosus) spinifer* Curtis, labial palpi and ligula.
Figure 73. *Phytosus (Phytosus) spinifer* Curtis, apical margin of mentum.
Figure 74. *Phytosus (Phytosus) spinifer* Curtis, outline of body, dorsal view.
Figure 75. *Phytosus (Actosus) nigriventris* (Chevrolat), outline of body, dorsal view.
Figure 76. *Phytosus (Actosus) balticus* Kraatz, outline of body, dorsal view.
Figure 77. *Antarctophytosus atriceps* (Waterhouse), apical margin of labrum.
Figure 78. *Antarctophytosus atriceps* (Waterhouse), labial palpi and ligula.
Figure 79. *Antarctophytosus atriceps* (Waterhouse), apical margin of mentum.
Figure 80. *Antarctophytosus atriceps* (Waterhouse), outline of body, dorsal view.

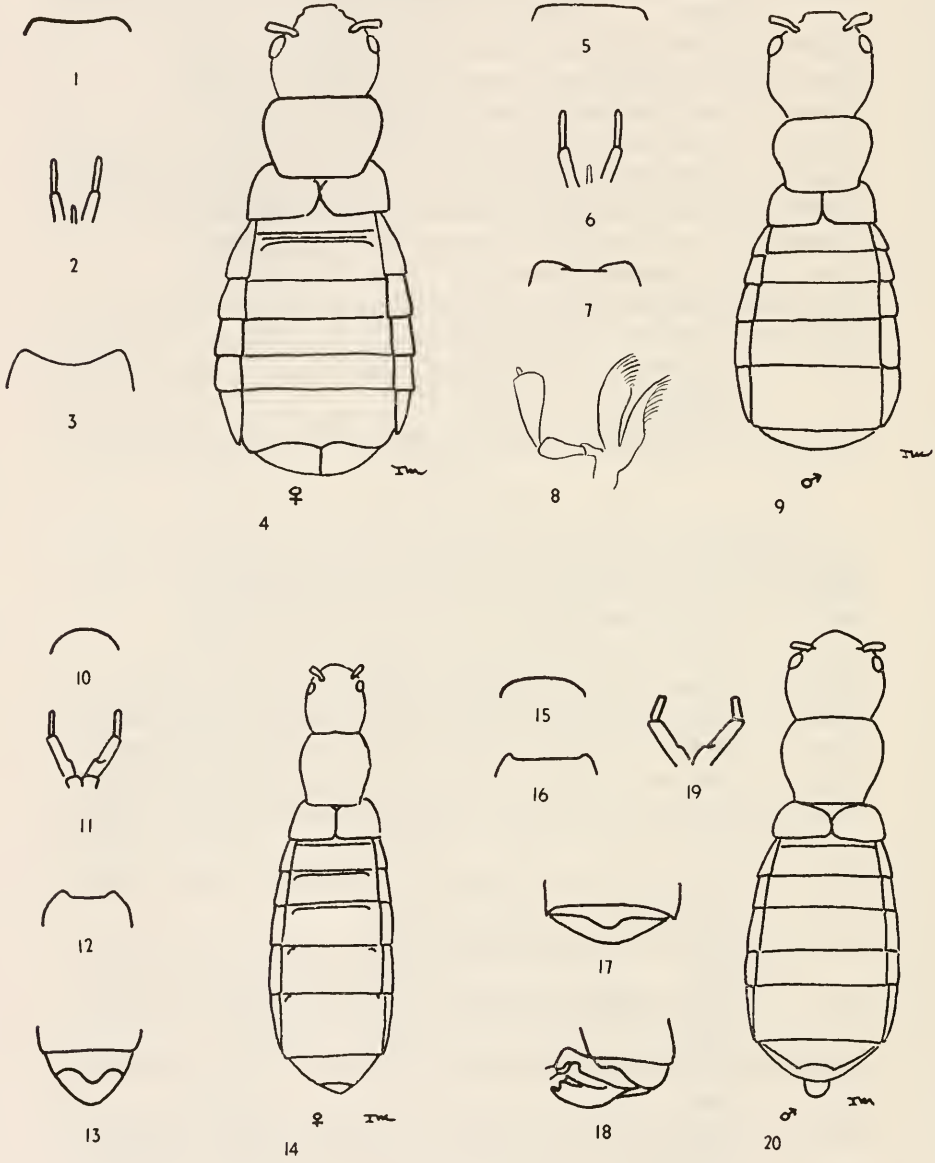

PLATE 8

FOR EXPLANATION OF FIGURES SEE PAGE 145

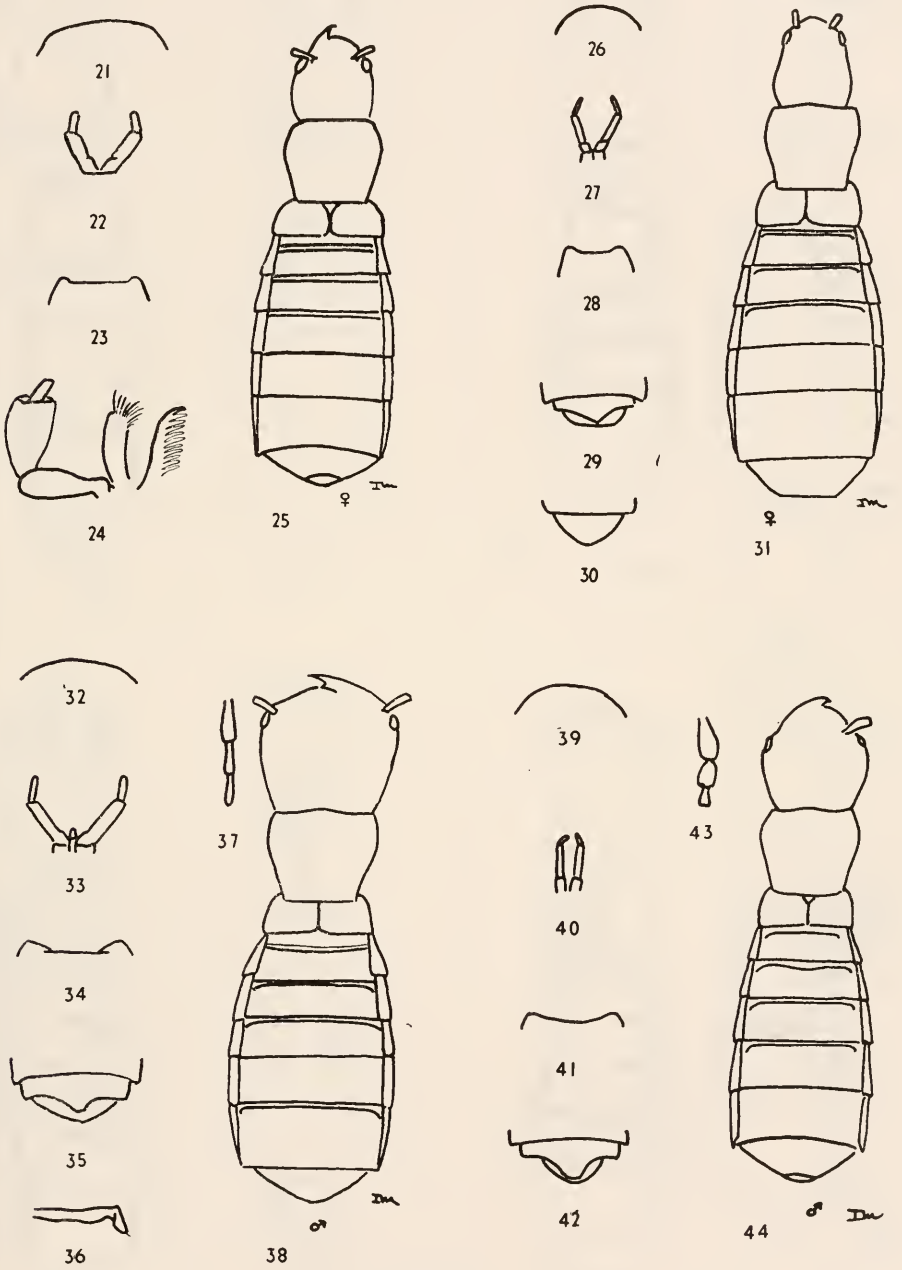

PLATE 9

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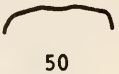
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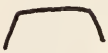
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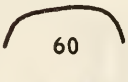
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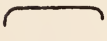
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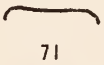
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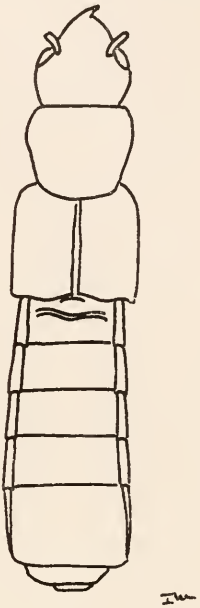
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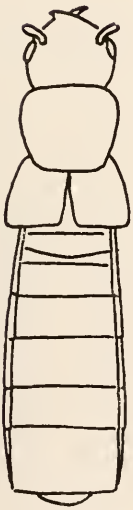
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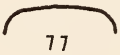
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PLATE 11

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII. No. 8, PP. 154–176, PLATE 12, 2 MAPS

MARINE PLEISTOCENE INVERTEBRATES FROM NEAR PUERTO PENASCO, SONORA, MEXICO

BY

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AND

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MARINE PLEISTOCENE INVERTEBRATES FROM NEAR PUERTO PENASCO, SONORA, MEXICO[1]

BY

LEO GEORGE HERTLEIN[2] AND WILLIAM K. EMERSON[3]

INTRODUCTION

This paper is based on a study of a collection containing 63 identified species and subspecies of metazoan invertebrates, mostly mollusks, taken from low terrace deposits in the Puerto Peñasco region of northwestern Sonora, México. It is the first general discussion of a Pleistocene faunule from that area to appear in the literature. Paleoecological interpretations are presented in an attempt to evaluate this faunal assemblage in terms of the known late Cenozoic distribution of the component species.

The occurrence of fossiliferous terrace deposits along the northern coast of Sonora, near Puerto Peñasco, was briefly mentioned in a paper by Lowe (1934: 3) concerning the Recent mollusks and in one by Gifford (1946: 215) on the archaeology of the area. Beal (1948: 30) observed low terraces at an elevation of about 20 feet above sea level along most of the Sonoran coast from Guaymas (Lat. 27° 55′ N.) to the head of the Gulf of California and on some of the islands off the coast of northern Sonora. He suggested that correlation of these terraces with similar terrace deposits on the coast of Baja California and the adjacent islands would be of considerable interest and would aid in the interpretation of the diastrophic history of the Gulf of California. Durham (1950) recently described the invertebrate fossils from several terrace deposits on the east coast of Baja California and of adjacent islands. In a paper dealing with high sea levels of the Sonoran shore, Ives (1951) discussed the occurrence of the "*Chione cancellata* beds"[4] in the vicinity of Punta Peñasco.

---

[1]Contribution from the Department of Geology, California Academy of Sciences, and from the Museum of Paleontology, University of California.

[2]Associate Curator, Department of Geology, California Academy of Sciences.

[3]Museum Paleontologist, University of California Museum of Paleontology.

[4]The species cited by Ives is probably referable to *Chione californiensis* Broderip.

A small number of fossil mollusks were collected by Professor Gifford (1946: 215) in 1944 and 1945 from raised beaches on the north side of Punta Peñasco. An examination of these specimens led the senior author to assign a late Pleistocene age to them. A few additinal specimens, obtained by Professor Gifford in 1948 and 1950 and presented to the University of California Museum of Paleontology, were examined by the junior author; this examination prompted him, accompanied by Arthur P. Loring, Jr., and Jerry A. Powell, to visit the area in December, 1954. The large collection of fossils and the acquisition of field data resulting from this trip, together with the specimens and information provided by Professor Gifford, form the basis for this paper. The senior author has collaborated in the preparation of the manuscript and has identified the mollusks.

The writers wish to acknowledge the very helpful assistance received in the field from Messrs. Loring and Powell and the many courtesies extended by Professor Gifford. Acknowledgment also is due to Dr. Robert J. Menzies of the Scripps Institution of Oceanography for information concerning the species of fossil crab, and to Dr. John D. Soule of the Allan Hancock Foundation, University of Southern California, for kindly identifying the species of Bryozoa. Dr. John S. Garth of the latter institution furnished information concerning the distribution of decapod crustacea in the Gulf of California region, and he also identified the single species of fossil crab in the present collection.

GENERAL DESCRIPTION OF AREA

Fossils were collected at Punta Peñasco (Lat. 31° 18′ N.) and at Punta La Cholla (Lat. 31° 20′ N.), prominent headlands situated between Bahía de San Jorge on the south and Bahía de Adair on the north (figs. 1, 2). South of Punta La Cholla, the coast line follows a south-southeast direction as a sandy beach[5] and then recedes somewhat to form a small bay, Bahía Punta Peñasco (Rocky Point Bay), on the north side of Punta Peñasco. The village of Puerto Peñasco is located

[5]F. Shreve remarked on the origin of the beach sands of this portion of the Gulf of California in his paper dealing with the distribution of the adjacent sandy areas on the mainland (see Yearbook Assoc. Pac. Coast Geogr., Vol. 4, pp. 11-12, 1938).

Figure 1. Index map showing the general location of the Puerto Peñasco area and the adjacent region.

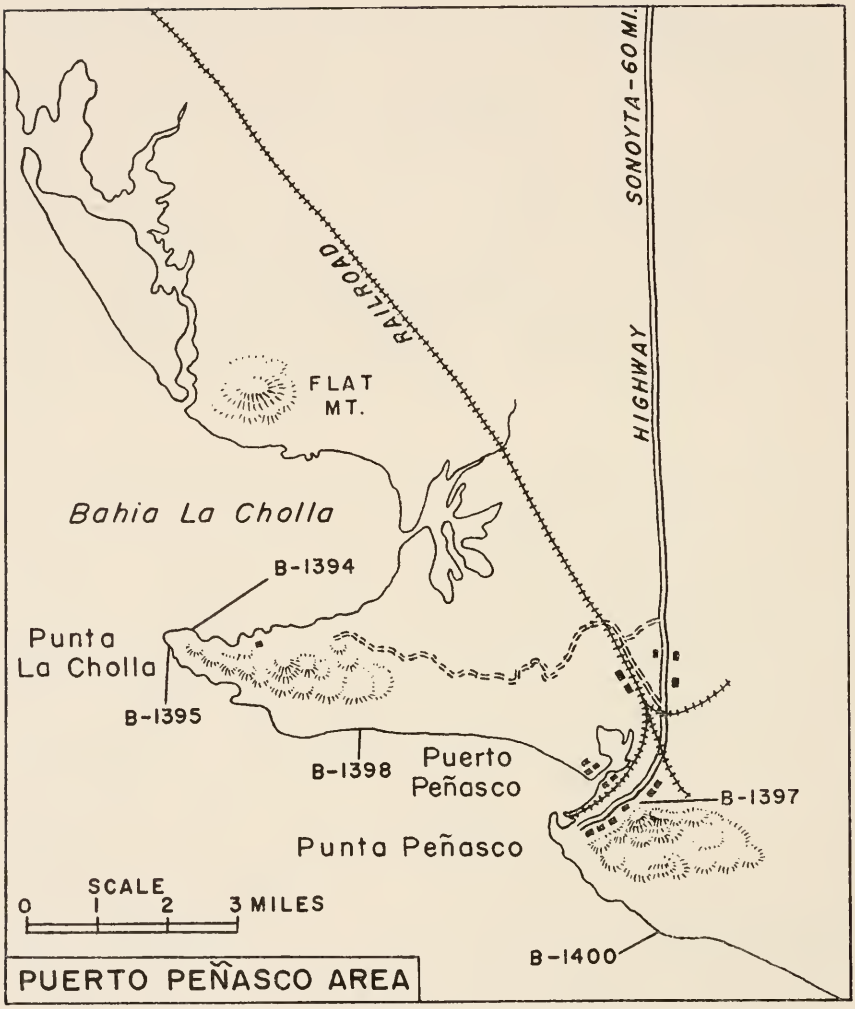

FIGURE 2. Sketch map showing the location of the principal collecting stations mentioned in the present paper.

on the south shore of the bay and is served by the Ferrocarril Fuentes Brotantes Punta Peñasco railroad, a spur line of which runs out to the headland along the south shore of Rocky Point Bay. A paved highway connects Puerto Peñasco with the town of Sonoyta, Sonora, and extends north, where it crosses the international boundary into Arizona. Punta La Cholla may be reached from Punta Peñasco by a graded dirt road.

PUNTA PEÑASCO AREA

Punta Peñasco, or Rocky Point, is a volcanic headland of weathered basaltic blocks and scattered pumice fragments forming a low hill which attains a maximum elevation of 226 feet[6]. Remnants of a terrace deposit abutting against the north side of the headland reach a maximum elevation of about 20 feet. At the edge of the village, a highway cut exposes fossiliferous sandstone 1 to 6 feet in thickness which is overlain by 1 to 10 feet of sparsely fossiliferous cobble conglomerate, Locality B-1397[7]. This very fossiliferous sand grades locally into a well cemented coquina containing small rocks and pebbles. Between the railroad spur tracks and the shore of the bay, Professor Gifford found a poorly consolidated fossiliferous sand exposed in the bank of the railroad cut, Locality A-4878. In this vicinity, fossiliferous sands also were located by him in a cut near an oil storage tank at an elevation of about 10 feet above high tide level, Locality A-6602, and at an elevation about 10 feet stratigraphically higher and approximately 100 yards south of this outcrop, Locality A-6603. The last two exposures, which were not found by the junior author and party in December, 1954, may have been destroyed by building activity in the area.

On the southwest side of Punta Peñasco, a wave-cut bench was noted about 10 feet above sea level. Wave action has eroded nearly all of the terrace sediments off the bench platform and only small patches of well indurated fossiliferous sand remain in the tidal zone, Locality

[6]Anonymous, 1938, page 170.
[7]Locality numbers refer to the University of California Museum of Paleontology unless otherwise stated.

B-1400. The sandstone grades locally into a coquina and overlies large blocks of basalt. The fossils at this locality are very poorly preserved due to the permeation and leaching action of water.

It is quite probable that marine waters at one time extended farther inland than is indicated by the extent of the fossiliferous sediment in this area.[8] Hornaday (1908: 270) was of the opinion that in comparatively recent times an arm of the Gulf of California extended up the Sonoyta valley as far as the Playa Agua Dulce. He based this opinion partly on the occurrence at places of marine shells, citing as examples the occurrence of *Cardium elatum* and *"Pectunculus"* [=*Glycymeris*] *gigantea* near the Playa Salada below Agua Dulce. However, as pointed out by Ives (1935: 337), evidence of former extension of marine waters based upon isolated occurrences of marine shells should be carefully considered, especially in regions where mollusks were used for food and as articles of trade by the aborigines. The present collection is composed of shells collected in place and nearly all contain some of the cemented matrix.

PUNTA LA CHOLLA AREA

Situated approximately five miles west-northwestward of Punta Peñasco is Punta La Cholla, or Rocky Bluff, a headland composed of a series of low granitic hills, the highest of which is 408 feet in elevation.[9] On the north side of the point lies a small bight which is known locally as Bahía de Cholla. Overlying the granitic rocks exposed in the intertidal zone just inside of the entrance to the bight are isolated ledges of well indurated sandstone containing granitic pebbles, rocks up to three inches in diameter and occasional fossils, Locality B-1394 (plate 12, figure 3). Along the west side of the headland, numerous undercut and partially slumped ledges of fossiliferous sandstone are exposed in the tidal zone. Fossils were collected from well-indurated sandstone outcropping in the tidal zone on the south side of the headland, immediately north of the large sand beach, Locality B-1398.

---

[8]Strata in southwestern Yuma County, Arizona (Lat. 33° 10′ N.), containing unidentified species of barnacles as well as *Corbicula*(?) and other brackish water fossils are considered to be of late Tertiary age [see E. D. Wilson, Science, New Ser., Vol. 74, No. 1927, pp. 567-568, December 4, 1931; Arizona Bur. Mines, Bull. 134, Geol. Ser. No. 7 (Univ. Arizona, Bull., Vol. 4, No. 2), pp. 31, 32, February 15, 1933].

[9]Anonymous, 1938, page 170.

With the exception of sandstone remnants in the tidal and infratidal zones of the beach, erosion has removed the terrace sediments from the southern and most of the western portions of the headland. The terrace is preserved, however, along a 200 yard stretch of the northwest coast, at a maximum elevation of 20 to 25 feet[10] and abuts against the headland a few hundred feet from the shore line (plate 12, figure 1). The cliff face exposes a basal 4 to 10 feet of poorly sorted, very fossiliferous sand with interbedded pebbles and boulders up to two feet in diameter, Locality B-1395 (plate 12, figure 2). The conglomerate is covered by a thin veneer of soil in which Recent mollusks of apparent kitchen midden origin are extremely common.[11] The sandstone is weakly cemented above the spray zone of the surf, and locally contains large pockets of coquina. This locality proved to be the most fossiliferous encountered; however, because of selective leaching of the fossils in the surface exposures, many of the faunal elements are represented by internal molds. In contrast, several groups, including the oysters, pectens, thaisids, tegulids and barnacles, are well preserved. Durham (1950: 4) commented on the prevalence of differential leaching of fossils in some of the late Tertiary and Pleistocene formations of the east coast of Baja California and concluded, on the basis of data from Clarke and Wheeler (1917), that the presence of a relatively high $MgCO_3$ content in the fossils may be a primary prerequisite for their preservation. Similar differential leaching of fossil shells occurring under desert conditions at Puerto San Bartolomé (Turtle Bay) on the west coast of Baja California was mentioned by Jordan and Hertlein (1926: 414).

---

[10]R. L. Ives (1951) mentioned the occurrences of two well-defined high sea level terraces along this portion of the Sonoran coast, one at 75 feet and one at 115 feet in elevation, the latter dated as possibly corresponding to the Sangamon or Yarmouth stages, Pleistocene. He also mentioned that other terraces occur along this coast varying from heights of 250 feet above present sea level to perhaps 30 feet below it. He suggested the possibility that some of these may be detached, possibly faulted, portions of the main wave cut bench occurring at an elevation of 115 feet.

During the field work upon which the present paper is based, emphasis was directed toward tracing fossiliferous strata and collecting the embedded fossils. The only terrace which received particular attention from the collectors was the one at 20 to 25 feet in elevation. No fossiliferous exposures were noted at elevations greater than 25 feet above sea level.

[11]Gifford (1946, page 216) listed eight species of mollusks, all of which are living in the adjacent waters, from kitchen middens on the north side of Punta La Cholla.

DESCRIPTIONS OF COLLECTING STATIONS

B-1394 Isolated ledges of well-indurated fossiliferous sandstone containing granitic pebbles and rocks overlying granitic rocks exposed in the intertidal zone just inside the entrance to the bight at Punta La Cholla, Sonora, México. W. K. Emerson and A. P. Loring, Jr., collectors; Dec. 19, 1954.

B-1395 Poorly-cemented fossiliferous sandstone, 4 to 10 feet in thickness and overlain by 2 to 10 feet of conglomerate, outcropping in terrace face exposed as sea cliff along a 200 yard stretch of the northwest side of Punta La Cholla, Sonora, México. Principal fossil locality. W. K. Emerson, A. P. Loring, Jr., and J. A. Powell, collectors; December 19-20, 1954.

B-1397 Fossiliferous sandstone 1 to 6 feet in thickness exposed in highway cut at edge of village of Punta Peñasco, Sonora, México; W. K. Emerson, A. P. Loring, Jr., and J. A. Powell, collectors; December 21, 1954.

B-1398 Well-indurated fossiliferous sandstone outcropping in intertidal zone on the south side of the headland immediately north of a large sandy beach at Punta La Cholla, Sonora, México. W. K. Emerson and A. P. Loring, Jr., collectors; December 21, 1954.

B-1400 Well-indurated fossiliferous sand overlying blocks of basalt on terrace on the southwest side of Punta Peñasco, Sonora, México. W. K. Emerson and A. P. Loring, Jr. collectors; December 21, 1954.

Collecting stations at Punta Peñasco, near Puerto Peñasco, Municipio de Caborca, Sonora, México, at edge of town, between railroad spur tracks and Rocky Point Bay, Prof. Edward W. Gifford, collector:

A-4878 Fossiliferous stratum exposed in railroad cut at track bed level; rock type: poorly consolidated sands. December, 1948.

A-6602 Fossiliferous stratum exposed at cut along oil storage tank, approximately 10 feet above high tide level; rock type: unconsolidated sands. March 3, 1940.

A-6603 Fossiliferous stratum exposed approximately 100 yards south of Loc. A-6602 and about 10 feet higher stratigraphically than Loc. A-6602; rock type: locally consolidated sands, grading into a coquina. March 3, 1950.

LIST OF SPECIES FROM THE PLEISTOCENE NEAR PUERTO PEÑASCO, SONORA, MÉXICO

PELECYPODA	B-1394	B-1395	B-1397	B-1398	B-1400	A-4878	A-6602	A-6603	Recent at Pta. Peñasco or adjacent region (12, 13, 14)
Anomia peruviana d'Orbigny		x							x
Apolymetis cf. *A. cognata* Pilsbry & Vanatta		x							x
Arca gradata Broderip & Sowerby			x						x
Arca solida Sowerby						x			x
Brachidontes multiformis Carpenter[15]						x			x
Cardium elatum Sowerby	x								x
Cardium procerum Sowerby	x	x		x		x			x
Chama frondosa mexicana Carpenter		x							
Chione californiensis Broderip[16]	x	cf.	x	x		x	x	x	x
Chione gnidia Broderip & Sowerby				x					x[12]
Codakia distinguenda Tryon		x							x
Corbula nasuta Sowerby						x			x
Diplodonta orbella Gould			x						
Donax gracilis Hanley							x		x
Dosinia ponderosa Gray		x				x			x
Glans affinis californica Deshayes		x	x	x		x	x	x	x
Glycymeris maculata Broderip				cf.					x
Glycymeris multicostata Sowerby				x					x
Hormomya adamsiana Dunker[16]									x
Isognomon chemnitzianum d'Orbigny								x	x
Lithophaga sp. (impression)		x							
Lucina lampra Dall						x			x
Megapitaria squalida Sowerby		x		x		x			x
Modiolus capax Conrad		x							x
Ostrea angelica Rochebrune			x			cf.		cf.	x
Ostrea conchaphila Carpenter						x			
Ostrea palmula Carpenter		x	x			x	x		x
Pecten circularis Sowerby		x		x					x
Pecten vogdesi Arnold		x							x
Protothaca grata Say			x			x	x	x	x
Semele flavescens Gould		x							x
Semele guaymasensis Pilsbry & Lowe						x			x
Tagelus californianus Conrad	x		cf.						x[12]

[12]Kino Bay, Sonora, México.

[13]Tepoca Bay, Sonora, México.

[14]Georges Island, Gulf of California.

[15]A single, somewhat eroded valve is, with some doubt, referred to this species.

[16]Also from Pleistocene at Punta Peñasco, Sonora, México. Loc. 32112 (C.A.S.).

	B-1394	B-1395	B-1397	B-1398	B-1400	A-4878	A-6602	A-6603	Recent at Pta. Peñasco or adjacent region (12, 13, 14)
GASTROPODA									
Acanthina angelica I. S. Oldroyd		x	x					x	x
Acanthina muricata tuberculata Gray		x	x						x
Acmaea mesoleuca Menke			x						x
Aletes sp.		x							
Conus regularis Sowerby		cf.					x		x
Crepidula sp.		x							
Cypraea cf. *C. annettae* Dall		x							x
Diodora inaequalis Sowerby								x	x
Murex cf. *M. erythrostomus* Swainson							?	x	x
Murex radix nigritus Philippi	x	x	cf.						x
Nassarius leucops Pilsbry & Lowe[16]		cf.							x
Nerita scabricosta Lamarck		x						x	x
Oliva incrassata Solander		x		x					x
Oliva spicata Bolten		x					x		x
Olivella cf. *O. dama* Mawe		x							x
Polinices reclusianus Deshayes		x	x					x	x
Polinices uber Valenciennes	x								x
Pyrazus humboldti Valenciennes	x								
Solenosteira cf. *S. pallida* Broderip & Sowerby		x							x
Strombus galeatus Swainson		x							x
Tegula cf. *T. mariana* Dall		x							x
Tegula rubroflammulata Koch		x							x[12]
Tegula rugosa A. Adams		x	x					x	x
Thais haemastoma biserialis Blainville							x		x[13]
Turbo fluctuosus Wood		x	x						x
Turritella gonostoma Valenciennes	x			x	x				x[12]
ECHINOIDEA									
Encope sp.	x	x							

[17]Recent range: Point Conception, California, to Mazatlán, México, and south to Perú and the Galápagos Islands in 2 to 78 fathoms (Osburn, 1950: 54).

[18]Recent range: known only from Mazatlán, México, beach (type locality), and Panamá (Osburn, 1950: 104).

[19]Recent range: West America: San Felipe, Baja California, to Tepoca Bay, Sonora, México, to the island of La Plata, Ecuador, in 2 to 45 fathoms. Cape Blanco, west Africa (type locality). (Osburn, 1950: 31).

[20]Recent range: Angel de la Guardia Island in the Gulf of California to Chile and the Galápagos Islands. Originally described by Busk from Chiloe Island, Chile, and later cited by him as occurring at Mazatlán, México. It occurs commonly in the Galápagos Islands, according to Osburn (1952: 467).

[21]Recent range: Magdalena Bay to San Felipe, Baja California, and south to Las Vacas, near Capón, Perú, and the Galápagos Islands. Type locality: Mazatlán, México (Rathbun, 1930: 550).

	B-1394	B-1395	B-1397	B-1398	B-1400	A-4878	A-6602	A-6603	Recent at Pta. Peñasco or adjacent region (12, 13, 14)
BRYOZOA									
Antropora tincta Hastings[17]		x				x			
Caleschara mexicana Osburn[18]		x							
Conopeum commensale Kirkpatrick & Metzelaar[19]		x							
Hippopodinella adpressa Busk[20]		x							
CRUSTACEA									
DECAPODA									
Eriphia squamata Stimpson[21]		x							
CIRRIPEDIA									
Balanus cf. *B. amphitrite* Darwin var.		x							x
Balanus sp.		x	x						
Tetraclita squamosa cf. *T. s. stalactifera* form *confinis* Pilsbry		x			x		x		x[14]
VERTEBRATA									
FISH VERTEBRA	x								

This list contains 56 species and subspecies of identified mollusks, one echinoid, 4 bryozoans, 2 barnacles, 1 crab, and one fish vertebra. The mollusks, because of their large number and known ranges, furnish the basis for most of the present discussion of this Pleistocene faunule.

Of the total of 56 species and subspecies of mollusks, five, because of imperfect preservation, are not identified with certainty, but are compared to known species. Three others are cited only as to genera.

All except four of the total assemblage are known to occur at the present time in the Puerto Peñasco area or in adjacent waters (Lowe, 1935; Keen, 1947). The four species which have not been recorded from the region north of Ángel de la Guardia Island do occur in the Gulf south of that island, and it is quite probable that all these species may be found to occur with the others at or near Punta Peñasco. All the non-molluscan species in this faunule also have been recorded living in the Gulf of California. The general assemblage consists of rock dwellers and inhabitants of sandy beaches representing near-shore conditions similar to those existing in that region at the present time.

Cooper, in 1895 (p. 37), mentioned: "From small collections hitherto made in the northern end of the Gulf, quoted by Carpenter or Stearns, it appears that the species found there are more largely of the temperate fauna, many of them being identical with those from the same latitude on the west coast of the peninsula. This seems to indicate

that the dividing ridge, now 3,000 feet or more in altitude, was crossed by one or more channels within geologically recent times." Steinbeck and Ricketts (1941: see pp. 177-179, 306, 307) stated (p. 307): "The faunal differences between the northern and southern portions of the Gulf are well marked in most groups." However, on the preceding page the latter authors stated, concerning the fauna of the Gulf, that with the exceptions of the sponges and tunicates, "there are but slight affiliations with animals of the north temperate zones . . . " Garth (oral communication)* reported a decided difference in the decapod crab fauna in the northern and southern portions of the Gulf of California. These and other observations have led to at least two theories to account for such a supposed distribution. One of these assumes submergence of portions of Baja California during at least a portion of Pleistocene time, thus permitting free movement of marine animals between the waters of the open Pacific and the Gulf. The other theory assumes that cooling of marine waters during early Pleistocene time was sufficient to enable mollusks and other animals from southern California to migrate around Cape San Lucas and then move northward to the waters at the head of the Gulf of California where they became isolated on account of the later rise in temperature of the waters about the southern portion of the peninsula.

Wittich (1920: 123) mentioned the presence of "subfossil" marine shells in the peninsula at elevations of 1,052 meters above sea level, and Beal (1948: 28-33) mentioned observing such occurrences to heights of nearly 2,000 feet.[21] Beal, after a study of the evidence involved, concluded that it was probable that at least portions of the peninsula were submerged during Pleistocene time from 1000 to 1800 feet. Further investigation will be necessary before detailed information is available concerning such possible extent and pathway of marine waters across the peninsula during Pleistocene time.

It is true that there are certain species of mollusks in the waters at the head of the Gulf of California whose affinities are believed to lie with species on the Pacific coast of southern California and northern

[21] "The shells were occasionally in the form of terrace deposits, though at higher elevations they were usually found loose, and scattered over such wide areas and in such quantities as to indicate strongly that they were not carried there by man." (Beal, 1948:28). It is possible that some of the latter may prove to be the remains of aboriginal kitchen middens.

*A publication by Garth (1955) containing a discussion of this subject appeared after the present paper was submitted for publication. A reference to his paper is cited in the bibliography.

Baja California. Such species include *Panope globosa* Dall, *Acmaea dalliana* Pilsbry, *Acanthina angelica* I. S. Oldroyd and *Calliostoma gemmuloides* Lowe. However, the geographic and geologic ranges of many such species are imperfectly known at the present time. Furthermore, some species which occur in those waters which may appear to lend a temperate aspect to this faunal assemblage, such as *Cardium elatum* Sowerby, *Chione californiensis* Broderip, *Chione fluctifraga* Sowerby, *Modiolus capax* Conrad, *Tagelus californianus* Conrad, *Crucibulum spinosum* Sowerby, *Marginella californica* Tomlin, *Polinices reclusianus* Deshayes and *Ischnochiton "acrior* Carpenter,"* are in fact subtropical species which range north to southern California. These species range farther south of Cedros Island (a general dividing point between subtropical and warm temperate marine mollusks) than they do north of it. Also, most of them attain a larger size in the warmer, more southern waters.

Steinbeck and Ricketts remarked on the occurrence of the common California shore crab, *Pachygrapsus crassipes* Randall, in the waters of the northern portion of the Gulf of California. This occurrence, however, is not especially significant because this species also is known to occur at various localities[22] in the southern portion of the Gulf.

The knowledge of the diastrophic and faunal history of Baja California during the Pleistocene is very incomplete at the present time. It is possible that further investigations may reveal the presence of cool-water molluscan faunas of Pleistocene age south of Cedros Island and in the Gulf of California, but at the present time none are known. It has already been pointed out that, after a trip to Magdalena Bay in 1925, E. K. Jordan (1936: 109) was convinced that only one faunal zone (not two, one representing warm the other cool water conditions as suggested by him in 1924), occurs at that locality and is of late Pleistocene age. He concluded that the assemblage of fossils at that locality is one which lived under comparatively warm-water conditions at least no cooler than those now prevailing at Magdalena Bay.

*According to Berry, records attributed to *Ischnochiton acrior* Carpenter from the Gulf of California are applicable to *Stenoplax* (*Stenoradsia*) *magdalenensis* (Hinds, 1844) and those from southern California to *Stenoplax* (*Stenoradsia*) *heathiana* S. S. Berry (see Proc. Malacol. Soc. London, Vol. 26, Pt. 6, pp. 161–166, pls. 4, 5, figs. 1–6 in text, January, 1946).

[22]Dr. John S. Garth has informed us that this species also has been collected at the following localities in the Gulf of California: Agua Verde Bay, Puerto Escondido, Willards Point, Ángel de la Guardia Island, Pond Island, and Ensenada de San Francisco, Sonora.

The fossil mollusks from the Puerto Peñasco area show no marked differences from those now living there, nor do they differ from those occurring in that portion of the Gulf south of Ángel de la Guardia and Tiburón Islands. Many of these species range south to Panamá and even to northern Perú. There is no evidence indicated by these fossils to suggest any essential differences in climatic conditions existing at the time of deposition of the enclosing sediments with conditions now prevailing at that locality.

Many of the species of fossil mollusks from Punta Peñasco lived in the Gulf of California region during Pliocene and Pleistocene times. At least 26 have been recorded from beds of Pliocene age along the east coast of Baja California or on islands in the Gulf, and 41 from beds of Pleistocene age. In common with other molluscan assemblages of Pleistocene age from west México, 7 occur at San Quintín, 41 at Magdalena Bay, 10 at the Tres Marías Islands, and 15 in the Colotepec formation in Oaxaca. Undoubtedly the large number of species in common with the Pleistocene fauna at Magdalena Bay reflects similar depositional environments and also is due in part to the very large number of species recorded from those deposits.

The two species of barnacles cited in the present paper are known to occur in the northern portion of the Gulf at the present time. Four species of Bryozoa are present in this collection. One is known to range from San Felipe, Baja California, near the head of the Gulf of California, to Ecuador, another from Mazatlán, Sinaloa, México, to Panamá, the third from Point Conception, California, to Mazatlán, México, and south to Perú and the Galápagos Islands, and the fourth from Ángel de la Guardia Island in the Gulf of California to Chile and the Galápagos Islands. The single species of crab, identified by Dr. John S. Garth as *Eriphia squamata* Stimpson, has been recorded as ranging at the present time from Magdalena Bay to San Felipe, Baja California, and south to Las Vacas, near Capón, northern Perú.

SUMMARY

The present paper is based on field observations and study of collections of invertebrate fossils from the vicinity of Puerto Peñasco, Sonora, México, northeastern shore of the Gulf of California. These fossils occur in moderately indurated sands, varying from 3 to 20 feet in thickness, locally grading into deposits of coquina. These sediments

are generally flat-lying or only slightly inclined and lie disconformably upon blocks of basalt at Punta Peñasco and upon quartz diorite at Punta La Cholla.

The present study leads to the conclusion that the fossil mollusks, barnacles and bryozoans from Puerto Peñasco, near the head of the Gulf of California, are of late Pleistocene age. All of the species of mollusks have been found living at the present time in the Gulf of California, and all but five of these mollusks occur in the vicinity of Punta Peñasco. The single species of fossil crab has been recorded living in the waters between San Felipe, Baja California, and Perú. The three species of Bryozoa in the collection have been recorded living in the Gulf of California at the present time, and all range south as far as Panamá or Ecuador, one from Point Conception, California, to Perú and the Galápagos Islands. There are no elements in the fossil fauna which would indicate essential differences of paleoecological or paleotemperature conditions between the Pleistocene depositional environment and the conditions existing at the present time in the vicinity of Puerto Peñasco.

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Explanation of Plate 12

Figure 1. Terrace along beach at Punta La Cholla, showing basal sandstone overlain by a conglomerate, Locality B-1395.

Figure 2. Cliff face of terrace material composed of fossiliferous, poorly sorted sandstone containing interbedded pebbles and rocks and overlain by a conglomerate composed of granitic rocks and boulders, Locality B-1395.

Figure 3. Beach along north side of Punta La Cholla, inside entrance to Bahia La Cholla, showing residual ledges of fossiliferous sandstone overlying granitic rocks exposed in the tidal zone, Locality B-1394.

PLATE 12

TRANSACTIONS
OF THE
SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII. No. 9, pp. 177-180 JUNE 11, 1956

ADDITIONAL NOTES ON THE PLIOCENE AND PLEISTOCENE FAUNA OF THE TURTLE BAY AREA, BAJA CALIFORNIA, MEXICO

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BY

E. P. CHACE

Curator of Conchology, San Diego Society of Natural History

During July of 1954 the research ship ORCA, of the J. W. Sefton Foundation, made a trip to Port San Bartolomé (Turtle Bay), Baja California, and I was included in the group aboard as conchologist. The ship was in Turtle Bay from July 15 to 18.

On the first morning, I landed on the beach at the southeast section of the bay, where I sought marine shells, but found few. I then made a trip into the sand dunes back of the beach, looking for land snails. There I found many dead shells of *Micrarionta levis* (Pfr.), but no live specimens. Some fragments of fossil pectens were also observed, and, following that indication of fossils, I located a small exposure of Pliocene shells on the side of a low ridge, and collected a few pounds of material.

In 1926 Jordan and Hertlein[1] reported on an exposure of fossiliferous Pliocene strata southeast of the bay, and the spot which I found is probably the extreme western end of that exposure.

---

[1]Jordan, E. K., and Hertlein, L. G. Contributions to the Geology and Paleontology of the Tertiary of Cedros Island and Adjacent Parts of Lower California. Proc. Calif. Acad. Sci., (ser. 4) vol. 15, no. 14, pp. 409-464, pls. 27-34, 1926.

In 1933 Dr. Hertlein published an additional report on the Pliocene fauna of this region[2].

The following species are represented in the material taken from the small Pliocene exposure herein mentioned.

PELECYPODA

Ostrea megodon Hanl.
Ostrea vespertina Conr.
Pecten bellus hemphillii Dall
Pecten callidus Hertl.
Pecten cf. *P. cerrosensis* Gabb
Pecten cf. *P. cristobalensis* Hertl.
Pecten cf. *P. hakei* Hertl.

ECHINODERMATA

Dendraster ashleyi Arn.
Dendraster gibbsi humilis Kew

On July 16 a landing was made at the southwest corner of the bay, and here an apparently unreported exposure of Pleistocene fossils was found. This second locale was at the south end of the hills on the peninsula between the bay and the ocean.

Fossils were collected along the side of the hill for several hundred feet. The exposure is about one-fourth mile from the tide line, the top being about 50 feet above it. The total thickness was not determined.

The species found were:

PELECYPODA

Arca reeveana D'Orb.
Arca solida Sby.
Arca gradata Brod. & Sby.
Ostrea cumingiana Dkr.
Pecten circularis Sby.
Anomia peruviana D'Orb.
Pseudochama exogyra (Conr.)
Lucina nuttalli Conr.
Diplodonta orbella (Gld.)
Trachycardium procerum (Sby.)
Chione californiensis (Brod.)
Chione gnidia Brod. & Sby.
Megapitaria squalida (Sby.)
Protothaca grata (Say)
Apolymetis biangulata (Cpr.)
Semele flavescens (Gld.)
Crassinella cf. *C. varians* (Cpr.)
Pholad sp.? (a fragment)

[2]Hertlein, Leo George. Additions to the Pliocene Fauna of Turtle Bay, Lower California, with a Note on the Miocene Diatomite. Jour. Paleo. vol. 7, no. 4, pp. 438-441, December, 1933.

GASTROPODA

Terebra armillata Hds.
Conus californicus Hds.
Conus fergusoni Sby.
Conus perplexus Sby.
Conus purpurascens Brod.
Turricula maculosa (Sby.)
Cancellaria cassidiformis Sby.
Oliva incrassata (Sol.)
Oliva davisae Durham
Olivella biplicata (Sby.)
Macron aethiops (Rve.)
Nassarius tegulus (Rve.)
Purpura festiva (Hds.)
Eupleura triquetra (Rve.)
Thais biserialis (Blv.)
Acanthina lugubre (Sby.)
Vitularia salebrosa (King)
Cypraea arabicula Lam.
Cypraea annettae Dall
Bursa californica (Hds.)
Strombus granulatus Swain.
Truncatella californica Pfr.
Hipponix antiquatus (Linn.)
Crepidula onyx Sby.
Crucibulum imbricatum (Sby.)
Crucibulum spinosum (Sby.)
Polinices recluzianus (Desh.)
Lottia gigantea Gray
Astraea undosa (Wood)
Tegula aureotincta (Fbs.)
Tegula gallina (Fbs.)
Turbo fluctuosus Wood

ARTHROPODA

Tetraclita cf. *T. squamosa rubescens* Darwin

Many of the shells had weathered out of a stratum of sandy marl and had rolled, unbroken, down the slope. More time and some digging might have turned up other species. All the species on this list are members of the recent fauna of Baja California; 25 of them with ranges extending from nearby Cedros Island south; 4 of them with ranges extending north from Cedros Island, and the other 15 species are found both above and below Cedros Island. Apparently climatic conditions when this Pleistocene deposit was formed were similar to those existing today.

About one mile east of the village a large outcrop of rock juts into the bay. I visited this point to collect recent marine shells and there I observed some large blocks of rock containing fossil shells which had fallen from a point higher up. Time did not permit breaking up this rock to obtain specimens, and no material was brought in. This location awaits investigation at some future date.

I wish to extend thanks to Dr. L. G. Hertlein for his valued assistance in the identification of the material listed in this report; also to Dr. John A. Comstock for helpful suggestions in the preparation of this paper.

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TRANSACTIONS

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SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII. NO. 10, PP. 181-205, 1 MAP, PLATE 13

UPPER PLEISTOCENE MOLLUSCA FROM POTRERO CANYON, PACIFIC PALISADES, CALIFORNIA

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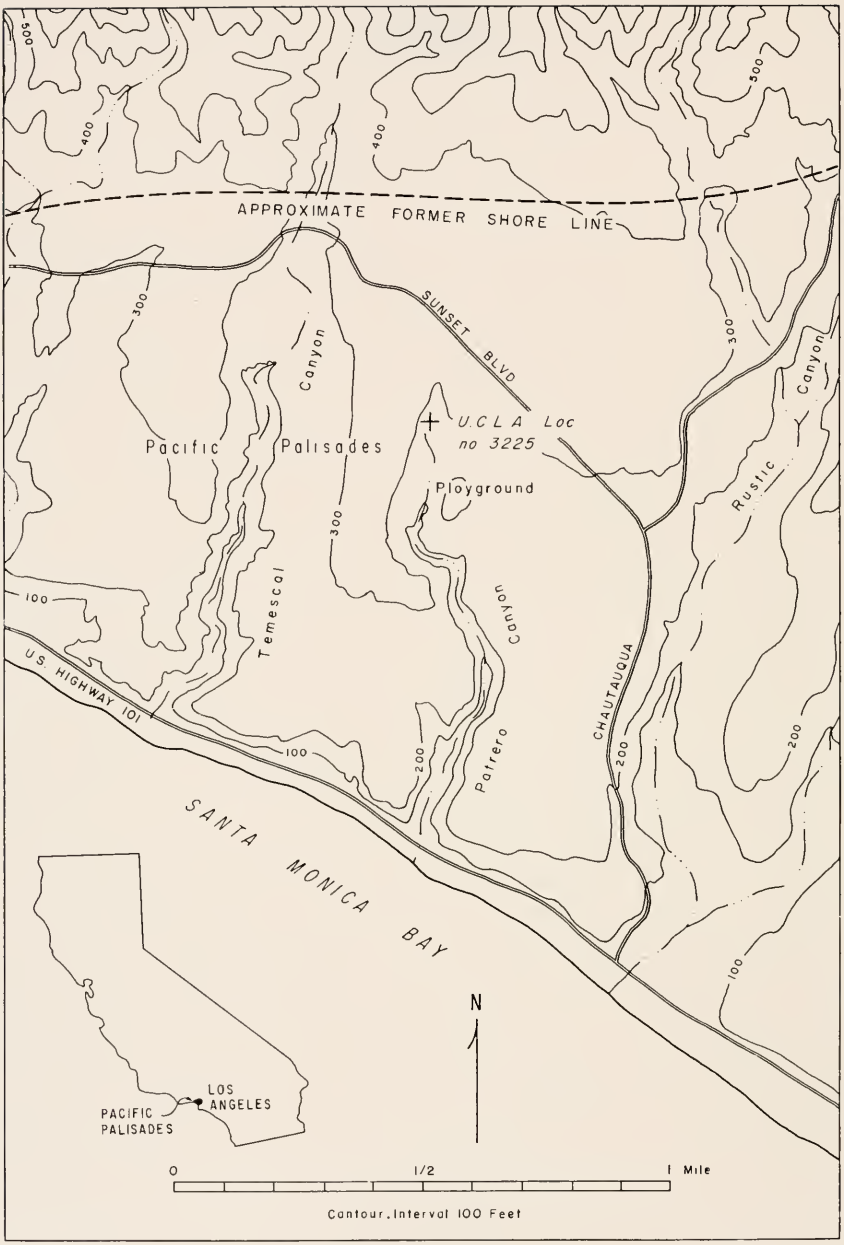

FIGURE 1. Index map of a portion of Pacific Palisades, California, showing the locality from which the Clark collection was recovered (UCLA Loc. no. 3225) and its relation to the shoreline during maximum sea stand on the Dume terrace platform.

UPPER PLEISTOCENE MOLLUSCA FROM POTRERO CANYON, PACIFIC PALISADES, CALIFORNIA

BY

JAMES W. VALENTINE

INTRODUCTION

Fossiliferous marine terrace sands of Upper Pleistocene age are exposed near the head of Potrero Canyon, Pacific Palisades, California (figure 1). Tens of thousands of mollusks from this deposit, collected over a period of years by Dr. F. C. Clark, were acquired by the Department of Geology, University of California, Los Angeles, in January, 1943. The preparation of homesites and other construction in Potrero Canyon has caused removal or burial of the most fossiliferous portions of the terrace sands, so that Clark's original locality is destroyed, and his collection cannot now be duplicated. It is therefore desirable to record this large assemblage, which contains 128 species and varieties previously unreported from the Upper Pleistocene of Potrero Canyon.

PREVIOUS WORK

Ralph Arnold was apparently the first to assign strata at Potrero Canyon to the Upper Pleistocene; he referred to the soft, rudely stratified nonmarine deposits forming much of the Palisades at Potrero Canyon and southward as probable equivalents of the Upper San Pedro series, "from lithological and stratigraphical reasons" (1903, p. 56). This correlation cannot be validated at present, although it is likely that some of the nonmarine terrace cover is of Upper Pleistocene age.

Marine deposits that are now considered Upper Pleistocene were first reported from the Santa Monica Mountains in 1904 by Rivers, who mentions "Quaternary beach gravels" as capping strata that he called Pliocene. Rivers described two mollusks, *Cavolina telemus* var. *tricuspida* and *Strombiformis raymondi,* from the Upper Pleistocene. It is probable that these came from Potrero Canyon.

Following Rivers' paper, several records of species from Upper Pleistocene deposits at "Santa Monica" appear in the literature. These forms are with but one exception (*Anachis lineolata*) present in the Clark collection, and are presumed to be from Potrero Canyon. The earliest of these papers is by Raymond (1906), who recorded varieties of *Megasurcula carpenteriana* from the "Pleistocene of Santa Monica", attributing the collection to Rivers. Bartsch described *Alabina monicensis* from the "Upper San Pedro series at Santa Monica, California" in 1911, and in 1917 described a new species of *Balcis* (*monicensis*) and recorded three additional species of this genus (*micans, oldroydi,* and *rutila*) from the same locality. The first chitons were reported from "Pleistocene deposits of the Santa Monica Hills" by Chace (1917), who recorded 7 identified forms collected by Clark. More gastropods were described from the "Upper Pleistocene of Santa Monica" by T. S. Oldroyd in 1921 (*Anachis minuta* = *A. lineolata,* and *Epitonium clarki*), and a record of *Acteocina infrequens* by Dall (1922), from an unspecified locality in Santa Monica, may belong here.

The earliest specific reference to an Upper Pleistocene fossil locality in Potrero Canyon appears to have been made by Berry (1922, p. 412, as "Long Wharf Canyon"). Working with material supplied by Clark, he revised and expanded Chace's list of chitons to 9 species. It remained however for Hoots to locate accurately the Potrero Canyon exposures on a map (1931, pl. 16), accompanied by the most complete description of the fauna yet published (Woodring in Hoots, 1931, pp. 121-122). Woodring listed 121 forms, of which 89 were specifically identified. The fauna was interpreted as a warm-water assemblage, correlative with the Upper San Pedro of Deadman's Island (Palos Verdes sand). Differences between the San Pedro and Potrero Canyon Upper Pleistocene assemblages were ascribed to biofacies differences.

A considerable number of species from the Upper Pleistocene of "Santa Monica", presumably Potrero Canyon, were included among the Pleistocene records compiled in Grant and Gale's famous catalogue (1931). These records are based on specimens in the Oldroyd and Clark collections (now at Stanford University and the University of California, Los Angeles, respectively). More recently, Woodring has re-emphasized the southern aspect of the Potrero Canyon fauna while affirming his earlier correlations (in Woodring, Bramlette, and Kew, 1946, p. 106).

Present Work

Preparation and identification of the F. C. Clark collection at U.C.L.A. was begun by Mr. E. H. Quayle in 1944, but was put aside due to the press of other duties. This work was completed by the writer in 1955 during the course of studies of Pleistocene molluscan faunas. The material received from Dr. Clark included Pleistocene mollusks from localities other than Potrero Canyon, which had unfortunately become mixed with a few of the Potrero Canyon fossils. Material so contaminated had been preserved separately by the direction of Professor W. P. Popenoe. Attempts to identify the source of this mixed material proved fruitless, as much of it had been cleaned of matrix. It has accordingly been excluded from the present study.

There remain in the Clark collection 227 species and varieties of mollusks that are unquestionably from the Upper Pleistocene deposits in Potrero Canyon (U.C.L.A. Locality no. 3225). The fauna is herein listed, together with all known published records of fossils from the same locality. In listing previous records, the nomenclature has been revised to accord with present usage. The chitons were identified by Dr. S. Stillman Berry during the preparation of his monograph (Berry, 1922). A total of 262 molluscan species and varieties are now reported from Potrero Canyon Upper Pleistocene.

Species or varieties not previously reported as fossils are *Acteocina magdalenensis, Sulcoretusa xystrum* (plate 13, fig. 10), *Hanetia elegans* (plate 13, figs. 7, 8), *Odostomia farallonensis, Odostomia gravida, Alabina tenuisculpta* var. *phalacra,* and *Polinices draconis.*

Acknowledgments

Professors U. S. Grant and W. P. Popenoe, University of California, Los Angeles, and Dr. John T. McGill, Geologist, U. S. Geological Survey, aided the preparation of this paper by careful criticism and discussion. The Clark collection was made available to the writer through the courtesy of Mr. Takeo Susuki, Junior Research Geologist, University of California, Los Angeles. Dr. Leo G. Hertlein, California Academy of Sciences, kindly furnished comparative material and ecologic data on certain mollusks. The index map was drafted by Mr. Ronald H. Arntson, University of California, Los Angeles, and Mr. Armour C. Winslow, Louisiana State University, aided in the preparation of the plate.

STRATIGRAPHY OF THE TERRACE DEPOSITS

Remnants of a marine platform of abrasion, included by Davis in his Dume terrace (1931, p. 1098 ff.), are preserved beneath an alluvial cover in the Pacific Palisades region. The platform surface is eroded on tilted strata of considerable structural complexity, which range in age from Paleocene to Lower Pleistocene. Near the head of Potrero Canyon, about 0.1 mile south of U.C.L.A. Locality no. 3225 (figure 1), this surface is exposed in stream and road cuts. It is underlain here by gently tilted, gray-green, massive siltstones mapped as Pliocene by Hoots (1931, pl. 16), and overlain by 1 to 6 feet of essentially horizontal, iron-stained, crudely bedded, loosely consolidated, fine to medium grained, angular quartz sands. The sands, where exposed, are largely unfossiliferous; only a few scattered sponge spicules and small, badly worn shell fragments could be found. About 50 feet of alluvium overlie the sands.

The surface of the terrace platform is somewhat irregular, as is well shown in Davis' photographs (1933, pl. 55). In Potrero Canyon, at the locality mentioned above, a shallow depression in the platform surface is exposed on the east bank of the stream. Very fine, highly fossiliferous sand fills this depression; it is finer than the sands above but coarser than the underlying siltstones. The molluscan fauna is similar to that in the Clark collection; in addition, foraminifera, ostracodes, and the minute skeletal remains of various other groups of marine invertebrates are present.

Hoots reports that the locality from which the Clark collection was recovered (locality 61 of Hoots, 1931, p. 121) is in a fine white and brown sand resting directly upon the Pliocene siltstones. The matrix of the mollusks in the Clark collection agrees well texturally with the very fine fossiliferous sand exposed in the depression, and contains a similar microfauna. It seems likely therefore that the rich Upper Pleistocene fauna has come from a unit lying between the Dume platform surface and the barren, fine to medium grained sand exposed in Potrero Canyon today. The fossiliferous unit was apparently stripped off much of the terrace before the overlying sands were deposited.

Among the most abundant foraminifera from the fossiliferous unit are *Bolivina interjuncta* Cushman, *Uvigerina peregrina* Cushman, *s. l., Cassidulina californica* Cushman and Hughes, *Cassidulina translucens* Cushman and Hughes, and *Anomalina* cf. *A. schmitti* Cushman

and Wickendon. With the exception of the *Anomalina,* all these species are reported from formations beveled by the terrace platform in the Pacific Palisades region (Goudkoff *et al.* in Hoots, 1931, pp. 117-118), and as they live today in depths much too great for waters on the Dume terrace (see below; Natland, 1933) they have doubtless been reworked from the underlying strata. The *Anomalina* may be conspecific with a form that is now abundant in protected shallow water off Catalina Island, but that lives in moderately deep water as well (Natland, 1933). It may or may not represent an Upper Pleistocene microfauna.

PALEOECOLOGY

HABITAT

A summary of the habitats of Recent representatives of Potrero Canyon species is given in table 1. Most data on the ecology of Pacific Coast Mollusca are recorded in rather general terms, and therefore broad habitat categories have been used. Some of these categories require definition.

Under "protected shallow water" are tallied species which live in embayments or in quiet water along protected outer coasts, and which are commonly found above 5 fathoms; most of them are subtidal, while many range also into shallow offshore waters. "Ubiquitous" forms are found in such a variety of environments that they cannot be used as ecologic indicators in this study; few of them range into moderately deep water, however. "Offshore, shallow water" forms live in waters at least as shallow as 20 fathoms, but are found below most heavy

TABLE 1. Present habitats of species and varieties in the Potrero Canyon fauna.

Habitat	Species and Varieties	Per Cent
Protected shallow water	68	33.0
Ubiquitous	61	29.6
Offshore, shallow water	42	20.4
Exposed rocky shores	19	9.2
Offshore, moderately deep water	11	5.3
Exposed sandy shores	3	1.5
Pelagic; open ocean	2	1.0
Total for which data available	206	100.0

wave action; they are not recorded from very shallow, subtidal zones. The "offshore, moderately deep" category includes species known to be living only at depths greater than 20 fathoms.

From the table, it is clear that most of the species prefer quiet shallow waters. The habitats from which "ubiquitous" species were derived cannot be known, but if the same proportions hold for them as hold among the rest of the fauna, fully 76.4 per cent of the species tallied may represent shallow water habitats free from strong wave action. The great majority of individuals as well as of species have been drawn from these habitats. Of the 42 "superabundant"[1] species for which ecologic data are available, 23 live today in protected shallow water, 2 offshore in shallow water, and 1 each in rocky exposed shore and moderately deep water habitats. The remaining 15 are "ubiquitous".

TEMPERATURE

Using the present distribution of species and of water temperatures as a datum, it seems possible to estimate the approximate magnitude and range of water temperatures represented by the Potrero Canyon fauna. The present geographic ranges of about 75 per cent of the species includes the latitude of Potrero Canyon; all of the remaining 25 per cent (59 species) live today only south of the Potrero Canyon area. Northern end-points of the ranges of these species are found in the following areas: Santa Monica, 10 species; Redondo Beach, 11 species; San Pedro-Long Beach, 13 species; Newport Beach, 1 species; Catalina Island, 4 species; La Jolla-San Diego, 5 species; and Baja California, 15 species.

Thus, two-thirds of the south-ranging species have the northern end-points of their present ranges within 25 or 30 miles of Potrero Canyon, while one-third do not now live within 100 to 900 or more miles of the region. Among the most southerly species are *Trachycardium procerum* (Scammon's Lagoon to Peru), *Chione gnidia* (Cedros Island to Panama), *"Chione" picta* (Magdalena Bay to Panama), *Dosinia ponderosa* (Scammon's Lagoon to Peru), *Mulinia pallida* var. *modesta* (Baja California and the Gulf of California),

[1]Species listed as "superabundant" in the *Checklist of Species*, to follow, are represented by 256 or more specimens in the Clark collection.

Bivetopsia bullata (plate 13, figs. 1, 2; Cedros Island to Panama), *Hanetia elegans,* previously unreported fossil[2] (plate 13, figs. 7, 8; Cape San Lucas to Panama), *"Nassa" cerritensis* (Point Abreojos to Guaymas), *Centrifuga leeana* (Guadalupe Island to Cedros Island), *Tricolia variegata* (Magdalena Bay to Cape San Lucas), *and Ischnochiton acrior* (Cedros Island to Cape San Lucas).

Although no species are reported fossil at Potrero Canyon that live only to the north, several are essentially northward-ranging types. Among these are *Bornia retifera* (Monterey to the Santa Barbara Islands), *Mitromorpha interfossa* (Alaska to Catalina Island), *Ocinebra barbarensis* (British Columbia to San Pedro), and *Epitonium sawinae* (British Columbia to Catalina Island).

Mean annual near-shore sea-surface temperatures range from something below 61° F. in Santa Monica Bay to about 68° or 69° F. near Magdalena Bay and about 75° F. near Cape San Lucas (Hertlein and Grant, 1944, p. 72). Although northern and southern species in the Potrero Canyon assemblage may live today in waters warmer or cooler than mean annual temperatures can indicate, their present distribution strongly suggests that the range of water temperature off the Dume terrace coast was greater than at present. Waters no warmer than those in Santa Monica Bay today, together with waters perhaps, as a conservative guess, 8° F. warmer, seem to have been present contemporaneously, or perhaps in alternate seasons, during the sea-stand on the Dume terrace platform.

A mechanism which might account for this condition has recently been postulated (Valentine, 1955): shallow quiet waters were warmed at some time in the Upper Pleistocene either by increasing heat from the sun or by the introduction of warm southern water in countercurrents; at the same time, shallow waters in areas where upwelling occurred remained relatively cool. As it seems likely that the temperature of upwelling water was lower than at present during and shortly after glacial ages, relatively warm and cold water species may have been able to live in close proximity. Emerson (1956) has also discussed the effect of upwelling on molluscan faunas, and its significance in Pleistocene paleoecology.

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[2]Gratitude is expressed to George P. Kanakoff, Los Angeles County Museum, for identification of this species. Mr. Kanakoff has discovered *Hanetia elegans* in Upper Pleistocene deposits at Playa Del Rey, California.

INFERRED DEPOSITIONAL ENVIRONMENT

The position of the shoreline at high sea stand on the Dume terrace, indicated in figure 1, is an approximation based on the slope of the platform surface as extrapolated from localities where it is exposed, and on such evidence as is afforded by the present topography. No exposure of the shoreline angle was found. Although the precise position and character of the Dume shore cannot be determined, this approximation will serve as a basis for limiting the depth at which the fossils could have been deposited; the difference in elevation between the fossil locality and the shoreline angle is judged to be no more than 30 feet.

Conditions at and near the site of deposition may be limited by combining the geographic and faunal evidence. The fossil locality lay no farther than ½ mile from shore and under a probable maximum of 5 fathoms of water. Silt and fine sand composed the substratum. These conditions seem to be reflected in the ecologic composition of the fossil fauna, for Recent representatives of most of the species prefer or tolerate such an environment. The waters near the fossil locality were probably fairly quiet, and not consistently disturbed by wave action while the assemblage lived. Perhaps an offshore bar or spit protected this part of the platform at times from most wave action; Davis (1933, p. 1103) mentions this possibility in another connection. Moderately deep water or open ocean types must have been swept inshore by occasional storm waves, while exposed sandy beach and rocky shore forms may have been transported offshore through the action of currents and gravity.

AGE AND FAUNAL AFFINITIES

As noted above, the Dume terrace bevels tilted strata of Lower Pleistocene age, and the marine terrace deposits at Potrero Canyon contain a fauna characterized by many species that live today along the nearby coast, together with several markedly southern forms. Similar faunas are commonly found in strata assigned to the Upper Pleistocene of Southern California. The Potrero Canyon fauna may therefore be considered as Upper Pleistocene on both stratigraphic and faunal grounds.

Similarities between the Upper Pleistocene fauna described by Willett from Playa Del Rey (1937) and the Potrero Canyon assemblage are striking, as Woodring has noted (in Hoots, 1931, p. 122, and in Woodring, Bramlette, and Kew, 1946, p. 106). The two

faunas have 194 species and varieties in common, while 96 forms from Playa Del Rey are not reported at Potrero Canyon, and 68 of the Potrero Canyon forms are not known from Playa Del Rey. The Playa Del Rey assemblage is slightly the larger (290[3] *vs.* 262 species and varieties). Differences between the two faunas are much smaller than these figures indicate. Of the forms not found in both faunas, only 20 from Playa Del Rey and 17 from Potrero Canyon are represented by more than 10 specimens in the very large collections available from each locality. Relative abundances of species in each assemblage are remarkably alike. Several species common to the two localities are not reported elsewhere in the Pleistocene of Southern California. These include *Diacria trispinosa* (plate 13, figs. 3, 4), *Bivetopsia bullata* (plate 13, figs. 1, 2), *Engina strongi* (plate 13, fig. 9), *Hanetia elegans* (plate 13, figs. 7, 8), and *Calliostoma gloriosum* (plate 13, figs. 5, 6). Several species from Playa Del Rey that are unknown at Potrero Canyon are tidal marsh or mud flat forms, a biotope not represented at the latter locality. With this exception, both faunas have clearly been drawn from similar habitats within nearly the same range of ecologic conditions. Both faunas have essentially the same thermal significance as well.

The bearing of the Potrero Canyon assemblage on the age of the Rancho La Brea vertebrate fauna has been discussed by Grant and Sheppard (1939, p. 308), who point out that the Rancho La Brea deposits seem to be contained in the distal end of the Hollywood fan, one of a series of alluvial fans that blanket the northern margin of the Los Angeles basin. These fans appear to be roughly contemporaneous with nonmarine terrace cover at Pacific Palisades. The vertebrate fauna is thus probably Upper Pleistocene, and somewhat younger than the Potrero Canyon assemblage.

Precise correlation of the Dume terrace with individual terraces elsewhere in Southern California cannot yet be made, but the correlations suggested by Woodring (*loc. cit.*) are doubtless correct. That is, the Potrero Canyon assemblage belongs within a period of uncertain duration in the Upper Pleistocene that is characterized faunally by the presence of a prominent southern molluscan element in protected habitat biofacies; to this period of time also belong the lowest terrace in the Palos Verdes Hills and possibly several of the earlier terraces, the Playa Del Rey deposits, and their correlatives.

[3]The figures given for the Playa Del Rey assemblage differ slightly from Willett's, owing to the necessity for "splitting" or "lumping" a few forms in order to obtain uniform taxonomic treatment for both faunas.

CHECKLIST OF FOSSILS

KEY

Column 1, Clark collection:
- V—Very rare, less than 5 specimens.
- R—Rare, from 5 to 16 specimens.
- C—Common, from 17 to 64 specimens.
- A—Abundant, from 65 to 256 specimens.
- S—Superabundant, more than 256 specimens.

Column 2, Woodring in Hoots, 1941:
- X—Reported present.

Column 3, Grant and Gale, 1931:
- Clk—Attributed to the Clark collection.
- Old—Attributed to the Oldroyd collection.

Column 4, other authorities:
- B-1—Reported by Bartsch, 1911.
- B-2—Reported by Bartsch, 1917.
- Ber—Reported by Berry, 1922.
- Cha—Reported by Chace, 1917.
- Dal—Reported by Dall, 1922.
- Old—Reported by Oldroyd, 1921.
- Ray—Reported by Raymond, 1906.
- Riv—Reported by Rivers, 1904.
- Wdg—Reported by Woodring, 1946.

Column 5, present geographic distribution:
- P—Present range includes the latitude of Potrero Canyon.
- S—Known to be living only south of Potrero Canyon.
- E—Not known to be living.

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
PELECYPODA					
Nucula suprastriata Arnold	S	X	Old		P
Nuculana taphria (Dall)	S	X			P
Yolida cooperi Gabb	S				P
Ostrea lurida Carpenter	S				P
Leptopecten latiauratus (Conrad)	S	X			P
Leptopecten latiauratus var. *monotimeris* (Conrad)	S				P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Lima hemphilli Hertlein & Strong	V				P
Anomia peruviana d'Orbigny	C				S
Pododesmus macroschisma (Deshayes)	R	X			P
Modiolus fornicatus Carpenter	V				P
Lithophaga plumula (Hanley)	C				P
Periploma planiusculum Sowerby	C				P
Pandora punctata Conrad	C	X			P
Crassinella branneri (Arnold)	R				S
Crassinella nuculiformis Berry	V				E
Chama pellucida Broderip	C				P
Pseudochama exogyra (Conrad)	S	X			P
Epilucina californica (Conrad)	V				P
Here excavata (Carpenter)	C				S
Lucinisca nuttallii (Conrad)	S	X			P
Parvilucina tenuisculpta (Carpenter)	C	X			P
Diplodonta orbella (Gould)			Old		P
Kellia laperousii (Deshayes)	V				P
Aligena cerritensis Arnold	V				S
Mysella aleutica (Dall)	V				P
Bornia retifera Dall	V				P
Laevicardium elatum (Sowerby)	R	X			S
Trachycardium procerum (Sowerby)	C	X	Old		S
Trachycardium quadrigenarium (Conrad)	A	X			P
Trigoniocardia biangulata (Sowerby)	A				S
Chione gnidia (Broderip & Sowerby)				Wdg	S
Chione undatella (Sowerby)		X			P
Chione cf. *C. undatella* (Sowerby)	V				?
Chione undatella var. *simillima* (Sowerby)	A				S
"Chione" picta Dall	R				S
Protothaca tenerrima (Carpenter)		X			P
Saxidomus nuttalli Conrad	A				P
Transenella tantilla (Gould)		X			P
Amiantis callosa (Conrad)	A	X			S
Dosinia ponderosa (Gray)	V			Wdg	S
Cooperella subdiaphana (Carpenter)	V				P
Tellina buttoni Dall	V	X			P
Tellina idae Dall	S	X			S
Apolymetis biangulata (Carpenter)	C				P
Macoma indentata Carpenter	S	X	Clk		P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Macoma nasuta (Conrad)	S				P
Macoma secta (Conrad)	S		Old		P
Macoma yoldiformis Carpenter	V	X			P
Semele decisa (Conrad)	R				S
Semele rubropicta Dall	V				P
Donax gouldii Dall	V	X			P
Psammobia edentula (Gabb)	R				S
Tagelus subteres (Conrad)	V				P
Solen sicarius Gould	A	X			P
Siliqua lucida (Conrad)	R	X			P
Ensis californicus Dall	A	X			P
Mactra californica Conrad	A	X	Old		P
Spisula catilliformis Conrad	V				P
Spisula "dolabriformis Conrad"	R				P
Spisula hemphilli (Dall)	A	X			S
Mulinia pallida var. *modesta* Dall	V				S
Schizothaerus nuttallii (Conrad)	A	X			P
Platyodon cancellata (Conrad)	R				P
Cryptomya californica (Conrad)	S	X			P
"Corbula" luteola Carpenter	R	X	Clk		P
Panope generosa Gould	C				P
Hiatella arctica (Linnaeus)	V	X			P
Zirfaea pilsbryi Lowe	C	X			P
SCAPHOPODA					
Dentalium neohexagonum Sharp & Pilsbry	S	X			P
Cadulus fusiformis Pilsbry & Sharp	A	X			P
GASTROPODA					
Cavolina telemus var. *tricuspida* (Rivers)				Riv	P
Diacria trispinosa (Lesueur)	V				P
Acteon punctocaelatus (Carpenter)	C	X	Old		P
Acteon traski Stearns	R	X	Old		S
Acteocina culcitella (Gould)	S	X	Clk		P
			Old		
Acteocina inculta (Gould)	S				P
Acteocina infrequens (C. B. Adams)				Dal	S
Acteocina magdalenensis Dall	V				S
Sulcoretusa xystrum (Dall)	V				S
Coleophysis carinata (Carpenter)			Old		P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Coleophysis harpa (Dall)	S				P
Volvulella cylindrica (Carpenter)	S	X	Old		P
Cylichna attonsa Carpenter	S	X	Clk		P
Bulla cf. *B. punctulata* A. Adams	V				?
Williamia peltoides (Carpenter)	R		Old		P
Terebra pedroana Dall	S	X	Clk		P
Conus californicus Hinds	S	X			P
Megasurcula carpenteriana (Gabb)	R	X		Ray	P
Megasurcula carpenteriana var. *tryoniana* (Gabb)	A			Ray	P
Antiplanes perversa (Gabb)	V				P
Pseudomelatoma penicillata var. *semiinflata* Grant & Gale	A				E
Moniliopsis incisa (Carpenter)	?	X	?		P
Moniliopsis incisa var. *fancherae* (Dall)	S				P
Moniliopsis incisa var. *ophioderma* (Dall)	S				P
Clavus hemphilli (Stearns)	S	X	Clk		P
Kurtzia arteaga var. *roperi* (Dall)	C				P
"Mangelia" cetolaca Dall	S	X			E
"Mangelia" variegata Carpenter	S		Old		P
Mitromorpha cf. *M. interfossa* Carpenter		X			?
Bivetopsia bullata (Sowerby)	R				S
Olivella baetica Carpenter	S				P
Olivella biplicata (Sowerby)	S	X	Clk		P
Olivella pedroana (Conrad)		X			P
Hyalina californica (Tomlin)	R				S
Cystiscus regularis (Carpenter)		X			P
Cystiscus subtrigona (Carpenter)	V				P
Mitra fultoni Smith	R		Old		S
Mitra idae Melvill	R				P
"Fusinus" luteopictus Dall	C				P
Barbarofusus barbarensis (Trask)	R	X			P
Harfordia monksae (Dall)			Old		P
Kelletia kelletii (Forbes)	V				P
Engina strongi Pilsbry & Lowe	V			Wdg	S
Hanetia elegans Dall	V				S
"Nassa" cerritensis Arnold	C				S
"Nassa" delosi Woodring	S	X			E
"Nassa" fossata (Gould)	S	X			P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
"Nassa" mendica Gould			Old		P
"Nassa" mendica var. *cooperi* Forbes	C		Clk		P
"Nassa" perpinguis (Hinds)	S	X	Clk		P
"Nassa" tegula Reeve	V				P
Anachis lineolata (Reeve)				Old	S
Mitrella carinata (Hinds)	A		Clk		P
Mitrella carinata var. *gausapata* (Gould)	S	X	Clk		P
			Old		
Mitrella gouldi (Carpenter)	V				P
Mitrella tuberosa (Carpenter)	C				P
Amphissa versicolor Dall	C	X			P
Pteropurpura trialatus (Sowerby)	R				P
Pterynotus petri (Dall)	C				P
Centrifuga leeana (Dall)	C				S
Jaton festivus (Hinds)	S	X	Old		P
Maxwellia gemma (Sowerby)	A				P
Ocinebra barbarensis (Gabb)		X			P
Ocinebra circumtexta (Stearns)	V				P
Ocinebra foveolata (Hinds)	V				P
Ocinebra interfossa Carpenter	V				P
Ocinebra poulsoni Carpenter	S	X			P
Stramonita biserialis (Blainville)	A			Wdg	S
Nucella emarginata var. *ostrina* (Gould)	R				P
Acanthina lugubris (Sowerby)				Wdg	S
Acanthina paucilirata (Stearns)		X			S
Acanthina spirata (Blainville)	A				P
Boreotrophon stuarti (Smith)		X			P
Forreria belcheri (Hinds)	C				P
Epitonium bellastriatum (Carpenter)	A	X	Old		P
Epitonium clarki T. S. Oldroyd	S			Old	E
Epitonium cooperi Strong	A				P
Epitonium insculptum (Carpenter)	V				E
Epitonium sawinae Dall	A				P
Epitonium tinctum (Carpenter)		X			P
Balcis micans (Carpenter)	C		Clk	B-2	P
Balcis monicensis (Bartsch)	R			B-2	E
Balcis oldroydi (Bartsch)	V			B-2	P
Balcis rutila (Carpenter)	C			B-2	P
Balcis thersites (Carpenter)	R				P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Strombiformis raymondi (Rivers)	R			Riv	S
Turbonilla almo Dall & Bartsch	A				P
Turbonilla asser Dall & Bartsch	R				P
Turbonilla canfieldi Dall & Bartsch	C				P
Turbonilla carpenteri Dall & Bartsch	V				S
Turbonilla keepi Dall & Bartsch	A				S
Turbonilla laminata (Carpenter)	R				S
Turbonilla lowei Dall & Bartsch	A				P
Turbonilla lowei var. *pedroana* Dall & Bartsch	C				P
Turbonilla pentalopha Dall & Bartsch	V				S
Turbonilla regina Dall & Bartsch	S				P
Turbonilla stylina (Carpenter)	R				P
Turbonilla tenuicula (Gould)	C				P
Turbonilla torquata (Gould)	R				P
Turbonilla tridentata (Carpenter)	R				P
Turbonilla weldi Dall & Bartsch	A				S
Odostomia cf. *O. californica* Dall & Bartsch	V				?
Odostomia donilla Dall & Bartsch	C				S
Odostomia eugena Dall & Bartsch	R				S
Odostomia farallonensis Dall & Bartsch	C				P
Odostomia gravida Gould	A				P
Odostomia helena Bartsch	C				P
Odostomia cf. *O. minutissima* Dall & Bartsch	A				?
Odostomia nemo Dall & Bartsch	S				S
Odostomia cf. *O. phanella* Dall & Bartsch	V				?
Bursa californica (Hinds)	A	X			P
Pusula californianus (Gray)	V		Old		P
Pusula solandri (Sowerby)			Old		S
Erato columbella Menke	V	X	Old		P
Alabina monicensis Bartsch				B-1	E
Alabina tenuisculpta var. *diegensis* Bartsch	V				S
Alabina tenuisculpta var. *phalacra* Bartsch	R				S
Bittium attenuatum Carpenter		X			P
Bittium rugatum Carpenter	V				S
Bittium cf. *B. rugatum* var. *giganteum* Bartsch		X			E
Bittium rugatum var. *larum* Bartsch	R				S

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Seila montereyensis Bartsch	R	X	Clk		S
Cerithiopsis antefilosa Bartsch	R				S
Cerithiopsis arnoldi var. *fossilis* Bartsch		X			E
Cerithiopsis cosmia Bartsch	R				P
Cerithiopsis pedroana (Bartsch)	R				S
Cerithiopsis pedroana var. *fatua* Bartsch		X			E
Triphora pedroana (Bartsch)	R				S
Metaxia diadema Bartsch			Clk		P
Alvania acutelirata (Carpenter)	V	X			S
Rissoina pleistocena Bartsch	C	X			E
Turritella cooperi Carpenter	A	X			P
Aletes squamigerus Carpenter	V		Clk		P
Spiroglyphus lituella (Morch)	R				P
Caecum californicum Dall	V	X			P
Micranellum crebricinctum (Carpenter)	S	X			P
Fartulum hemphilli Bartsch	R				S
Fartulum occidentale Bartsch	C				P
Littorina planaxis Philippi	V		Clk		P
Littorina scutulata Gould	C				P
Lacuna carinata Gould	V		Clk		P
Lacuna carinata var. *aurantiaca* Carpenter	R				P
Lacuna unifasciata Carpenter	S	X	Clk		P
Alaba catalinensis Bartsch	V				S
Alaba jeannettae Bartsch	V				S
Hipponix antiquatus (Linnaeus)			Clk		P
Hipponix tumens Carpenter	V		Clk		P
Crepidula adunca Sowerby		X	Clk		P
Crepidula excavata (Broderip)	S		Old		P
Crepidula nummaria Gould	C	X			P
Crepidula onyx Sowerby	A		Old		P
Crepipatella lingulata (Gould)	C	X			P
Crucibulum spinosum (Sowerby)	V		Clk		P
Calyptraea contorta Carpenter	C	X			P
Polinices draconis Dall	R				P
Neverita reclusiana (Deshayes)	A				P
Neverita reclusiana var. *alta* Arnold	S	X			P
Neverita reclusiana var. *imperforata* Dall	S				P
Euspira lewisii (Gould)	V				P
Sinum debile (Gould)			Clk		S
Sinum cf. *S. debile* (Gould)	V				?

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Sinum scopulosum (Conrad)	S				P
Acmaea insessa (Hinds)		X			P
Tricolia compta (Gould)	C				P
Tricolia pulloides (Carpenter)	S	X			P
Tricolia variegata (Carpenter)		X			S
Pomaulax undosus (Wood)	A	X			P
Homalopoma carpenteri (Pilsbry)	C				P
Norrisia norrisi (Sowerby)	A				P
Tegula aureotincta (Forbes)	S	X			P
Tegula gallina (Forbes)	A				P
Tegula ligulata (Menke)	A	X			P
Calliostoma annulatum (Humphreys)		X			P
Calliostoma doliarium (Holten)	C				P
Calliostoma gemmulatum Carpenter	C				P
Calliostoma gloriosum Dall	V				P
Calliostoma cf. *C. splendens* Carpenter			Old		?
Calliostoma supragranosum Carpenter	V	X			P
Calliostoma tricolor Gabb	S				P
Turcica caffea Gabb	V				P
Pupillaria optabilis (Carpenter)	A	X			P
Vitrinella? sp	V				S
Skenea californica (Bartsch)	V				P
Diodora aspera Eschscholtz			Old		P
Megatebennus bimaculatus (Dall)	V				P
AMPHINEURA					
Leptochiton clarki Berry				Ber	E
Mopalia acuta (Carpenter)	R			Ber	P
Acanthochitona avicula (Carpenter)				Ber	P
Ischnochiton acrior Carpenter	R			Ber	S
				Cha	
Ischnochiton conspicuus Carpenter	V	X		Ber	P
				Cha	
Ischnochiton pectinulatus Carpenter	R			Ber	P
Ischnochiton sanctaemonicae Berry	A			Ber	E
				Cha	
Callistochiton crassicostatus Pilsbry	C			Ber	P
				Cha	
Callistochiton palmulatus var. *mirabilis* Pilsbry	A			Ber	P
				Cha	

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EXPLANATION OF PLATE 13

Figs. 1, 2. *Bivetopsia bullata* (Sowerby), approximately natural size. Hypotype, U.C.L.A. coll., no. 27480. Length, 45 mm., diameter of last whorl, 34 mm. U.C.L.A. Loc. no. 3225.

Figs. 3, 4. *Diacria trispinosa* (Lesueur), approximately X 5¼. Hypotype, U.C.L.A. coll., no. 27381. Length, incomplete, 7.6 mm., width, incomplete, 6.5 mm. U.C.L.A. Loc. no. 3225.

Figs. 5, 6. *Calliostoma gloriosum* Dall, approximately X 2. Hypotype, U.C.L.A. coll., no. 27482. Length, 17 mm., diameter of last whorl, 13 mm. U.C.L.A. Loc. no. 3225.

Figs. 7, 8. *Hanetia elegans* Dall, approximately natural size. Hypotype, U.C.L.A. coll., no. 27483. Length, 41 mm., diameter of last whorl, 26 mm. U.C.L.A. Loc. no. 3225.

Fig. 9. *Engina strongi* Pilsbry & Lowe, approximately X 2. Hypotype, U.C.L.A. coll., no. 27484. Length, 14 mm., diameter of last whorl, 8 mm. U.C.L.A. Loc. no. 3225.

Fig. 10. *Sulcoretusa xystrum* (Dall), approximately X 15½. Hypotype, U.C.L.A. coll., no. 27485. Length, 1.7 mm., greatest diameter, 0.8 mm. U.C.L.A. Loc. no. 3225.

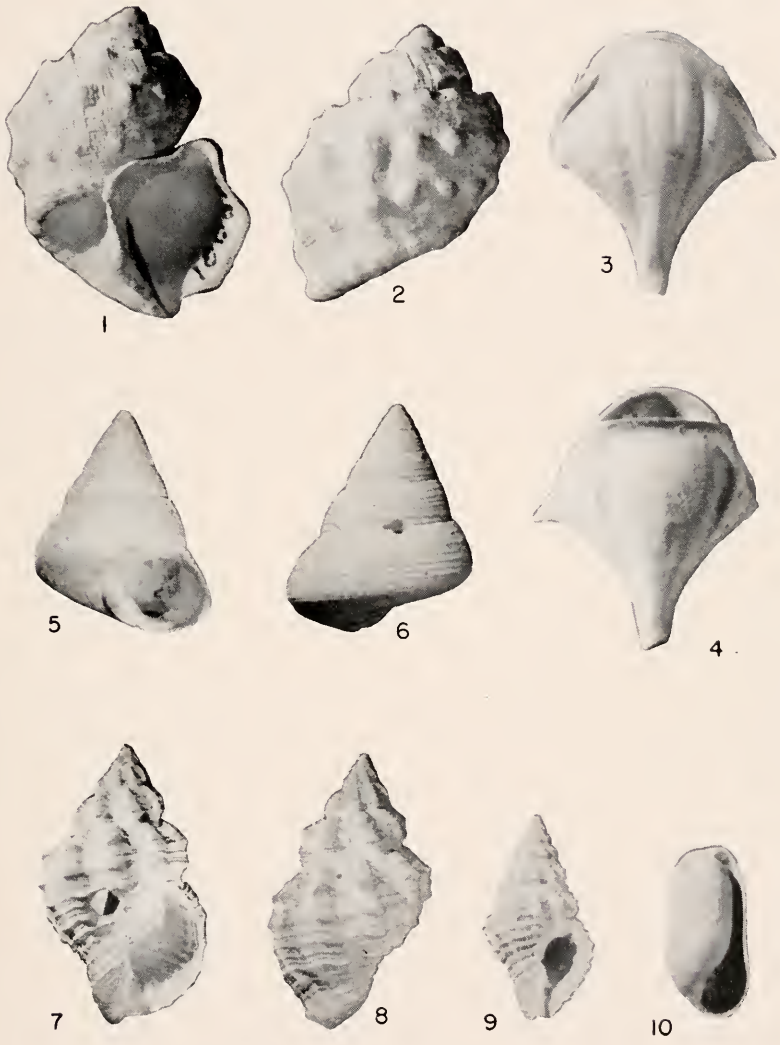

Plate 13

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII. No. 11, pp. 207-230. PLATES 14-17

NOTES ON SOME INTERTIDAL COLEOPTERA WITH DESCRIPTIONS OF THE EARLY STAGES (CARABIDAE, STAPHYLINIDAE, MALACHIIDAE)

BY

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INTRODUCTION

The rich and varied insect fauna of the Southern California seashore has been little investigated except for the describing and naming of species. The several distinctly different ecological situations in this realm, each of which supports its own assemblage of insect species, can be readily located in relation to each other according to the type of shore and to the range of the tide. The beetle fauna falls naturally into three main zones, with almost no overlapping of species between them. The three zones are determined by the type of shore: whether it is (1) a mud flat of a bay or estuary, (2) a sandy beach, or (3) a rocky headland with a submerged reef. The beetle fauna of the mud flats is the least apparent of the three and is little known on the California coast. The sandy beaches support a very extensive insect fauna, of which Coleoptera comprise a major part. Of the three quite obvious horizontal subdivisions of this zone, each has its own group of species, a few of which are common to more than one subdivision. In the lowest subdivision, that of the fresh seaweed and wet sand, which is characterized by the presence of numerous amphipods, will be found *Thinopinus pictus* LeConte and *Dyschirius marinus* (LeConte). The next subzone is a narrow belt of patches of decaying seaweed, which is probably reached by only one or two high tides a month. Here are found a large number of species of beetles that feed largely on the larvae of the kelp flies. Most, but not all, of the genera found here are restricted to the sea beach. They include *Cafius, Bryonomus, Bledius, Aleochara, Phaleria,* and *Cercyon.* Above this subzone is an area of patches of dry seaweed that are probably left there by a major storm or an exceptionally high tide. The genera, which again are largely restricted to this subzone, and some of which are representatives of families more commonly associated with dried cereals, include *Epantius, Phyconomus, Catorama,* and *Endeodes.* The upper limit of this zone marks the edge of the intertidal area and the beginning of the sand-dune area, the fauna of which more closely resembles that of the desert fifty or more miles to the east. The last major zone, that of the rocky headlands and reefs, supports a fauna of beetles capable of living submerged in seawater for long periods. Two species of *Diaulota*

TABLE 1
ZONES OF THE SOUTHERN CALIFORNIA SEASHORE IN WHICH COLEOPTERA ARE FOUND, WITH SOME CHARACTERISTIC GENERA

1. MUD FLATS	2. SANDY BEACHES	3. ROCKY HEADLANDS AND REEFS
	A. Area of dry seaweed *Endeodes* *Catorama* *Epantius* *Amblyderus* *Anthicus* *Phyconomus* *Phaleria*	A. Area of spray (Species from Zone 2B often take refuge here in cracks in the rocks.)
B. Area of sea-lettuce *Cicindela* *Tachys* *Bembidion* *Carpelimus*	B. Area of decaying seaweed *Cercyon* *Saprinus* *Bledius* *Bryonomus* *Cafius* *Hadrotes* *Pontamalota* *Thinusa* *Bryobiota* *Tarphiota* *Aleochara* *Emplenota* *Motschulskium* *Phaleria* *Phycocoetes* *Emphyastes*	B. Area of high tides *Thalassotrechus* *Diglotta* *Bryothinusa* *Dianlota* (Also *Ochthebius, Amblopusa, Liparocephalus* and *Endeodes* in Central California)
	C. Area of fresh seaweed *Cicindela* *Dyschirius* *Thinopinus* (*Bryonomus* occasionally)	C. Area of red seaweed down to mean low water *Dianlota*

are found as far down as mean low water. Other species are found within a foot or two of average high water and some species are found more commonly within the spray zone just above high water. All are found most often in fine, well-drained cracks in the rocks. Table 1 indicates the relation of the various zones to each other as well as some of the commoner forms of Coleoptera to be found in each subzone.

This paper deals with the beetles of the rocky shores of Southern California, with particular emphasis on the descriptions of the larvae of these forms and their near relatives of central California.

CARABIDAE

THALASSOTRECHUS Van Dyke

This genus, described in 1918 by Van Dyke, was based on *Trechus barbarae* Horn[1] from Santa Barbara, California. At the time that Van Dyke described the genus, he also described another species, *Thalassotrechus nigripennis* Van Dyke from Moss Beach, San Mateo County, California. In 1951 I sent some examples of the genus to Van Dyke for identification and he wrote saying that all the southern specimens were *barbarae* and all the northern *nigripennis*. He stated that there was very little difference between the two and that he had actually considered *nigripennis*, when he described it, to be a subspecies of *barbarae*. My own series, now over one hundred specimens, substantiates this view.[2] There is no consistent observable structural difference between the two forms, but if the specimens are divided into two groups, one from the north of Point Conception and one to the southward, certain characters stand out prominently. *Nigripennis* is distinctly larger, darker, and more shining. In a long series of larvae, I can find no structural difference, but most of the specimens of *nigripennis* are again definitely darker. Although Van Dyke considered certain specimens that I had collected at Gaviota, Santa Barbara County, California, as belonging to the northern subspecies, I now find that they are much closer to the southern series. The dividing point between the two subspecies is somewhere between Point Conception and the Big Sur region of Monterey County. The region just north of Point Conception seems

[1] *Anatrechus* Casey, 1918, Memoirs on the Coleoptera, VIII, p. 411, was based on the same species. According to Casey, 1920, p. 185, it appeared about a month after Van Dyke's paper and so is a synonym of *Thalassotrechus*.

[2] Since the above was written, I have received from Dr. P. J. Darlington a copy of his *The American Patrobini*, Ent. Amer., vol. 18, No. 4, pp. 135-183, 1938, in which he discusses *Thalassotrechus* in some detail in a long footnote on pages 143-144, and states that the two forms are best considered subspecies. This suggested change has not yet been recorded in the Leng supplements.

to be a barrier to the intertidal Coleoptera. Only one species of the genus *Endeodes* is known to occur on both sides of this area, the species of *Diaulota* are distinctly separated near this region, and *Liparocephalus cordicollis* LeConte and several other northern species are not known south of San Luis Obispo County. These observations are in accord with those of marine zoologists, many of whom consider Point Conception a dividing line between two faunal areas.

The following is the distribution of the two subspecies as represented in my collection:

Thalassotrechus barbarae barbarae (Horn)

Punta Morro, north of Ensenada, Baja California, México: adults and larvae in November, larvae in April.

La Misión de San Miguel, Baja California: adults in November.

San Diego, California: adults in October, larvae in March, April, and November.

Gaviota, Santa Barbara County, California: adults in October and November.

Thalassotrechus barbarae nigripennis Van Dyke

Pacific Grove, Monterey County, California: adults and larvae in October.

Moss Beach, San Mateo County, California: adults and larvae in October.

Van Dyke reported it also from Marin County, California.

It must not be assumed from the foregoing dates that these forms are necessarily found only in the spring and fall. The main reason for these capture dates is probably that the very favorable spring and fall tides lead one to search for intertidal insects at these times. On the summer trips time is spent more commonly on the beach when the kelp fauna is richest and when low tides are usually at an unfavorable time of day. *Thalassotrechus* is not particularly common, but when it is found, several specimens are often together. It is encountered near the upper reaches of the intertidal area in well-drained cracks in the rocks, in association with *Liparocephalus cordicollis* LeConte in central California, and with *Diaulota fulviventris* Moore in southern California and Baja California. As when collecting other intertidal rock-dwelling insects, the cracked rocks must be split open with a wrecking bar or some other implement to expose the insects. When uncovered, the adults run for shelter rather rapidly, but by no means as fast as most small terrestrial carabids. The larvae are more sluggish than the adults and probably feed on the larvae of chironomid flies, which are often found with them.

Larva of **Thalassotrechus barbarae** Horn

Body elongate, cylindrical, somewhat depressed. Color testaceous to piceous, head and pronotum often lighter than abdomen. Integuments very shining, heavily chitinized, glabrous except for rather sparsely placed, long, strong setae. HEAD quadrate, about as wide as long. Eyes of six ocelli on each side near the anterior angles; anterior three ocelli largest. Coronal suture meeting frontal sutures at angles of 120 degrees. Frontal sutures biarcuate, the two arcs meeting in an inward pointing cusp. Mandibles falcate, slender, as long as head, with a small tooth at the middle of the inner margin. Antennae half as long as mandible; the last and penultimate segments each strongly geniculate; the penultimate bearing a small acorn-shaped seta at middle of its strongly diagonally beveled apex and one long seta on each side of apex; last segment with three long, strong setae at apex. Maxilla with lacina not separate from the stipes, galea with segments of equal length, the first segment with a long seta at the tip, second segment geniculate to first. Labial palpi two-segmented, first segment three times as long as wide, second one-third as wide as first and one-third as long. Ligula very small, one-fifth as long as first segment of labial palpi, semi-quadrate with a very long, stout seta at tip and a small seta on each side of tip. THORAX with first segment at widest part of body, a little longer than second or third, subquadrate but arcuate at posterior margin; second and third segments subquadrate, each considerably wider than long. ABDOMEN long, slender, tapering toward the tip; the tergal plates separated from the pleural plates by wide areas of membrane; tergal plates with distinct longitudinal suture. Urogomphus long, slender, not segmented, with three long spines at outer edge and three more at tip. Pseudopode two-thirds as long as urogomphus. LEGS pale, not strong, bearing one sharp claw. LENGTH 7.5 mm.

STAPHYLINIDAE

SUBFAMILY ALEOCHARINAE

The larvae of only four of the ten genera at present placed in the subtribe Phytosi of the tribe Bolitocharini have been discussed in the literature. As the larvae of *Diaulota* have never been described in detail, and larvae of four of the five known species are at hand, it seems worthwhile to describe these and to compare them with the known larvae of the other genera.

KEY TO THE KNOWN LARVAE OF THE GENERA OF THE PHYTOSI

A. Apex of ninth abdominal segment truncate ..... *Phytosus*
AA. Apex of ninth abdominal segment produced in two prominent appendages.
B. Urogomphus two-segmented ..... *Antarctophytosus*
BB. Urogomphus less than two-segmented
C. Antennae three-segmented ..... *Liparocephalus*
CC. Antennae four-segmented ..... *Diaulota*

PHYTOSUS Curtis

The larva of *Phytosus nigriventris* (Chevrolat) was described and figured by Fauvel in 1862. According to him, the antennae are of four segments; the first and last are small, and the supplementary segment (a modified seta of the second) is unusually long (it is figured as being about half as long as the third segment). The mandibles have no visible tooth internally. The eyes are of a single ocellus on each side. The maxillary palpi are of three segments; the first is quite small, the second several times as long, and the third long, setiform and sharply pointed, so that the entire palpus has the aspect of a long spine. He called particular attention to the enlarged middle and posterior femora. The eighth abdominal segment has a noticeable tubercle above, in the center of the apical margin. The ninth segment is apparently truncate without the prolongations (urogomphi) typical of *Diaulota.*

ANTARCTOPHYTOSUS Waterhouse

I am indebted to Renaud Paulian for bringing to my attention the fact that in a previous paper on the Phytosi I overlooked that, in 1941, he described the true larva of *Antarctophytosus* and showed that Enderlein's earlier description was based on a misidentification. According to Paulian, the antennae are three-segmented with the modified seta not as long as segment three. The mandibles are bidentate at the apex. The three-segmented maxillary palpi have the last segment acuminate. The labial palpi are two-segmented. The urogomphi are two-segmented with the first segment shorter and stouter than the second.

LIPAROCEPHALUS Mäklin

Saunders in 1928, and Chamberlin and Ferris in considerably greater detail in 1929, have published figures of the larvae of *Liparocephalus cordicollis* LeConte (as *L. brevipennis* Mäklin). I have specimens of the larvae from Pigeon Point, San Mateo County, California, before me, so any dif-

ference between the following brief description and former ones should be construed as my own opinion. The antennae are of three segments, the first short and wide, the second long and stout, the third slender but longer than the modified setae which with it occupies the apex of the second segment. The mandibles are curved, with a median tooth internally and with serrations basad from the median tooth. The eyes are of a single facet on each side. The maxillary palpi are three-segmented and the labial palpi two-segmented. The eighth abdominal tergite is produced medially near its apex in a large, dark, very prominent tubercle. The urogomphi are produced on each side of the apex of the ninth segment as a short, stout process to which is articulated a long, slender, stalk-like process, bearing at its tip a long seta.

DIAULOTA Casey

The larva of this genus has been figured in toto by Saunders in 1928, and some parts have been shown in greater detail by Chamberlin and Ferris in 1929. The antenna is of four segments, with the modified seta at the apex of the second, either longer or shorter than the third segment, depending on the species. The mandibles bear an internal tooth. In one species (*D. fulviventris* Moore) there are serrations between the median tooth and the tip. The eyes consist of a single facet on each side. The maxillary palpi are of three segments and the labial palpi of two. The tubercle at the dorsal apex of the eighth segment is not as pronounced as in *Liparocephalus*. The urogomphi are very large, variable specifically, and usually with a very minute segment articulated at the point.

The determinations as to species were made largely by association and elimination, but I am reasonably certain that they are correct.

KEY TO THE KNOWN LARVAE OF THE SPECIES OF DIAULOTA

A. Mandibles serrate internally between median tooth and tip ..... *fulviventris*
AA. Mandibles simple internally between median tooth and tip.
B. Urogomphi bent sharply upward at tip ..... *densissima*
BB. Urogomphi straight or nearly so.
C. Modified seta of second antennal segment at least as long as third .... *vandykei*
CC. Modified seta of second antennal segment much shorter than third ..... *megacephala*

Larva of **Diaulota densissima** Casey

Body elongate and subparallel, a little wider toward apex of abdomen. Integuments well chitinized, shining, sparsely punctured, and glabrous except for numerous setae, which are more abundant toward the sides. Color dark grey, with eighth abdominal segment black and ninth reddish;

under parts very pale. Head nearly round, as long as wide. Mandibles without serrations between median tooth and tip; median tooth very large. Antenna with first segment shorter than wide; second rectangular, over twice as long as wide, with a seta on each side near apex; third segment less than half as wide as second, about twice as long as wide, distinctly shorter than acorn-like seta at apex of second, with two small setae approximated near apex; fourth segment half as wide as third and about as long as wide, with two apical setae. Pronotum nearly square, widest at apex; sides nearly straight; about as wide as head. Second thoracic segment about half as long as pronotum and a little wider; third a little shorter and a little wider. Abdomen with first segment about as wide as thorax but somewhat shorter than third thoracic segment, second to seventh each a little longer than preceding, eighth longer than seventh but narrower, with the apex produced posteriorly in the center in a small wide lobe. Urogomphi bend sharply upward at tip. Legs pale, shining with a few setae. Length 1.8 mm.

This description is based on a specimen taken at Pigeon Point, San Mateo County, California, in October, in company with adults. This agrees well with the larva chosen by Chamberlin and Ferris as representative of this species.

The very long, modified seta of the second antennal segment and the sharply upturned urogomphus readily separate this species from the others.

Larva of **Diaulota fulviventris** Moore

Body elongate, subparallel, a little wider posteriorly. Integuments well chitinized, shining, sparsely punctured, and glabrous, except for numerous setae, particularly toward the side. Color black to reddish brown, paler below, with urogomphi testaceous. Head nearly round, a little narrowed in front. Mandibles with serrations between median tooth and tip. Antennae with first segment wider than long; second narrower, more than twice as long as wide, with two setae, one near the middle and the other near the apex; third segment half as wide as second, about twice as long as wide; fourth very small; modified seta at apex of second segment about half as long as third segment. Pronotum considerably wider than head, nearly twice as wide as long, second and third segments shorter but as wide as first. Abdomen very similar to that of *D. densissima* Casey. Length 1.6 mm.

Four specimens from Punta Morro, north of Ensenada, Baja Cali-

fornia, México, two in April and two in November, and nine specimens from La Jolla, San Diego, California, in September and November, all taken in company of the adults.

The larva of this species differs from all the other larvae by having serrations between the median tooth and tip of the mandibles. The larvae of this species and those of *D. densissima* Casey are more easily separated than are the adults of the two.

Larva of **Diaulota vandykei** Moore

Elongate, subparallel, but widest near the abdominal apex. Integuments shining but very minutely roughened. Color yellow to reddish brown, with eighth abdominal segment sometimes black. HEAD somewhat quadrate as in the adult. Mandibles without serrations between median tooth and tip. Antennae with first segment about as long as wide; second narrow, twice as long as wide, with a small median beanlike seta, on each side of which is a long seta; third segment three times as long as wide, with a seta on each side of apex; fourth short, modified seta at apex of second segment about as long as third segment. PRONOTUM subquadrate, a little wider than long; sides evenly arcuate. Second thoracic segment less than half as long as pronotum, a little wider; third about equal to second. ABDOMEN with eighth segment broad. UROGOMPHUS curved upward slightly at tip. LENGTH 1.9 mm.

Seven specimens from Shell Beach, San Luis Obispo County, California, were taken in company with over one hundred adults from a reef exposed near mean low water. Although these are not from the type locality and differ somewhat from the type series, I believe that they belong to this species.

The length of the modified antennal seta readily distinguishes this species.

Larva of **Diaulota megacephala** Moore or **Diaulota harteri** Moore

Elongate, wider posteriorly. Integuments smooth, shining, and glabrous, except for scattered setae. Color pale yellow to ferruginous, with a small black spot near the center of the eighth tergite. HEAD ovoid, wider than long. Mandibles without serrations between median tooth and tip. Antenna with first segment short; second twice as long as wide, a seta each side of apex; third less than half as wide as second, more than twice as long as wide, with a seta at apex; fourth very small, with two small

setae at apex; modified seta at apex of second segment as wide as third segment but only two-thirds as long. Pronotum subquadrate, wider than long, wider than head. Second and third segments about as wide as pronotum and about half as long. Abdomen with eighth segment produced in the center of the apical margin in a small, black, truncate lobe. Urogomphus long, slender, sharply pointed, and not curved upward at the tip. No minute articulation at tip of urogomphus. Length 1.4 mm.

Eight specimens taken at La Jolla, San Diego, California, in company with adults of both species which are usually found together. Because of the larger head it seems more likely that this is the larva of *megacephala* than of *harteri*. The former is the commoner species.

This larva is easily known by the simple tips of the mandibles and by the short antennal seta, as well as by the straight urogomphus.

MALACHIIDAE

ENDEODES LeConte

Of the five known species of *Endeodes*, I have examples of the larvae of the three semi-intertidal species. The larvae of the two southern species are unknown but apparently are not intertidal rock-dwellers; the adults are seashore inhabitants in the dry kelp above high tide. I believe no larva of this genus has as yet been described. The three closely related species discussed here are all found on the sea beaches of central California. Sometimes the adults are found under debris on the sandy beaches, but more commonly I have found adults and larvae together in damp cracks in the rocks just at, or just above, the high-tide mark.

Larva of **Endeodes collaris** (LeConte)

Body fusiform, roughly three and one-half times as long as wide. Color dark sand to piceous, with the head often ferruginous, the legs and undersides lighter, and the ninth abdominal segment entirely black above. Sometimes a triangular black spot in center of head, a large oblong central black spot and two small lateral black spots on pronotum, a small black spot on each side of second and third thoracic segments. First to eighth abdominal segments and usually all three thoracic segments with a pale circle on each side, in the center of which is a minute black spot. These pale circles are hardly apparent on the thorax of dark specimens. Head nearly square, shining, finely granulose throughout, sparsely and very finely pubescent with a few long setae near the ocelli. Eyes of four ocelli near the anterior angle, with the three front ocelli in a row. Coronal suture

meeting the straight frontal sutures at an angle of 120°. Mandibles deeply notched at tip to form two teeth, one dorsal to the other and with a small median tooth at inner edge. Antennae very short, retractable in a telescoping manner; first segment a little longer than wide; second narrower, half as long as wide, with three setae near apex; third segment less than half as wide as second and twice as long, with two setae remote from apex; the large acorn-shaped setae of second segment wider than third segment and nearly as long. Labrum distinct, apically arcuate. Maxillary palpi short and robust; each segment wider than long except the last, which is more than twice as long as wide. Labial palpi two-segmented; first segment twice as long as wide; second narrower but of same proportions. Ligula about as long as first segment of labial palpi, wide and broadly rounded at apex. THORAX not strongly chitinized, rather densely and minutely punctured throughout, and clothed with a very fine, pale pubescence; a strong lateral seta on each side of each segment; third segment widest, almost twice as wide as head. Pronotum subquadrate to oval, as long as head, half again as wide as long; second segment wider than first, more than twice as wide as long; third segment about as long as second and a little wider. ABDOMEN not chitinized, with first eight segments gradually narrower toward apex; first segment a little shorter than the others, which are subequal in length. Surface finely, not densely punctured, and finely, transversely rugulose, finely pubescent with a few moderate setae. Ninth segment heavily chitinized, finely granulose, finely pubescent with numerous strong setae. UROGOMPHUS not segmented, twice as long as wide, pointed; apex with a very small upturned hook. LEGS slender, pale, sparsely pubescent and shining, with a single claw at apex. LENGTH 5 mm.

Three specimens were taken at Santa Cruz, California, in September, in company with five adults. Five taken in October, at Pacific Grove, Monterey County, California, in cracks in the rocks just above high tide and just above the area in which *Liparocephalus* and *Diaulota* are found in this region. The rocks were covered with a heavy coating of bird droppings.

Larva of **Endeodes rugiceps** Blackwelder

Very similar to the larva of *E. collaris* (LeConte) but lighter in color and with the urogomphus ferruginous above and below, at least at its apical half.

Seven larvae from Pacific Grove, Monterey County, California; one adult and twenty-five larvae from Shell Beach, San Luis Obispo County,

California. At Shell Beach a point of soft sandstone dividing two small coves terminates in a precipitous cliff which, except at low tide, is moistened by the spray of a heavy surf. All the specimens were found in a horizontal crack at the top of a ledge which was about halfway down the cliff and about five feet above extreme high water. As pieces of stone were pried away from the ledge, the lower surface of the crack was exposed, revealing several larvae in an area about a foot square. Each larva was in a slightly oblong cell bounded by loose debris. The cell was about twice the length of the insect and about one-sixteenth of an inch thick (the thickness of the crack). From each cell ran a poorly defined pathway an inch or two long leading out to other areas of the crack. This pathway, which was about the width of the insect, was bordered by the same loose debris as the cell. It was most sharply defined where it joined the cell, becoming gradually more indistinct until it disappeared. The cells were separated from each other by several inches.

Larva of **Endeodes insularis** Blackwelder

A single larva and a single pupa were taken in company with several adults at Gaviota State Park, Santa Barbara County, California, and are assigned to this species because of their association with the adults. They were taken in company with *Thalassotrechus barbarae* (Horn) at different spots in the cracks of a tilted sedimentary deposit which would be covered by the high tide. This larva is inseparable from those of *E. rugiceps* Blackwelder and may belong to that species rather than this one.

Pupa of **Endeodes insularis** (?) Blackwelder

Body fusiform, strongly flattened dorsoventrally; head deflexed. Pale, testaceous throughout, transluscent; integuments soft and flexible, sparsely pubescent, and with numerous large setae. Nearly-formed body of adult clearly distinguishable within. Head, thorax, and abdomen each forming a close fitting, clearly demarked cover for those segments of adult. Each leg and each antenna with separate sack which closely approximates shape of these parts in adult except for being considerably stouter. Antennal sack clearly segmented and about twice as wide as the adult antenna, which can be seen lying loosely within. Length. 3.5 mm.

It is not possible to identify this pupa with certainty as that of *E. insularis* Blackwelder, but the association with the adults makes such an identification very likely correct.

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Explanation of Figures

Plate 14

Figure 1. Urogomphi and pseudopode of larva of *Thalassotrechus barbarae* (Horn).

Figure 2. Ocelli of larva of *Thalassotrechus barbarae* (Horn).

Figure 3. Larva of *Thalassotrechus barbarae* (Horn), dorsal view.

Figure 4. Labium and maxilla of larvae of *Thalassotrechus barbarae* (Horn).

Figure 5. Mandible of larva of *Thalassotrechus barbarae* (Horn).

Figure 6. Posterior leg of larva of *Thalassotrechus barbarae* (Horn).

Figure 7. Antenna of larva of *Thalassotrechus barbarae* (Horn).

PLATE 15

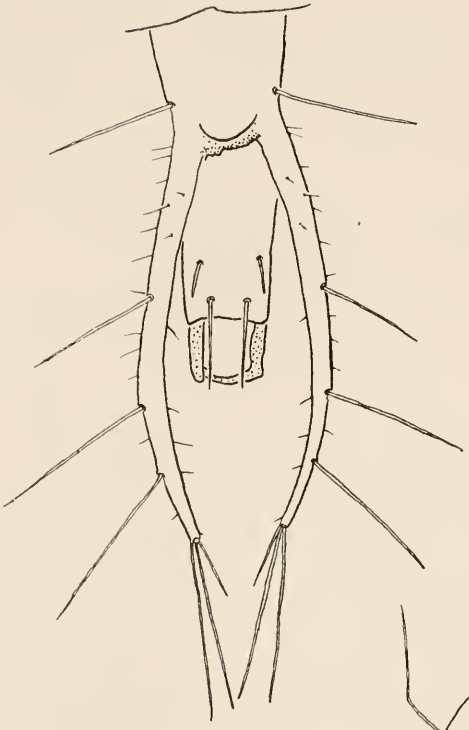
Figure 8. Antenna of larva of *Diaulota densissima* Casey.
Figure 9. Mandible of larva of *Diaulota densissima* Casey.
Figure 10. Outline of body of larva of *Diaulota densissima* Casey, dorsal view.
Figure 11. Ninth abdominal segment of larva of *Diaulota densissima* Casey, lateral view.
Figure 12. Antenna of larva of *Diaulota fulviventris* Moore.
Figure 13. Mandible of larva of *Diaulota fulviventris* Moore.
Figure 14. Larva of *Diaulota fulviventris* Moore, dorsal view.
Figure 15. Ninth abdominal segment of larva of *Diaulota fulviventris* Moore, lateral view.

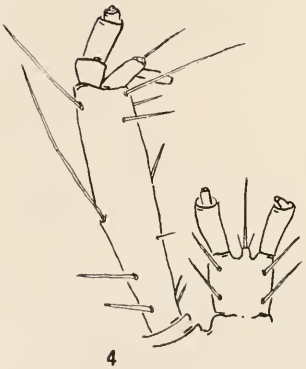
PLATE 16

Figure 16. Antenna of larva of *Diaulota vandykei* Moore.
Figure 17. Mandible of larva of *Diaulota vandykei* Moore.
Figure 18. Outline of body of larva of *Diaulota vandykei* Moore, dorsal view.
Figure 19. Ninth abdominal segment of larva of *Diaulota vandykei* Moore, lateral view.
Figure 20. Antenna of larva of *Diaulota megacephala* Moore or of *Diaulota harteri* Moore.
Figure 21. Mandible of larva of *Diaulota megacephala* Moore or of *Diaulota harteri* Moore.
Figure 22. Outline of body of larva of *Diaulota megacephala* Moore or of *Diaulota harteri* Moore.
Figure 23. Ninth abdominal segment of larva of *Diaulota megacephala* Moore or of *Diaulota harteri* Moore.

PLATE 17

Figure 24. Larva of *Endeodes collaris* (LeConte), dorsal view.
Figure 25. Antenna of larva of *Endeodes collaris* (LeConte).
Figure 26. Labium and maxillary palpus of larva of *Endeodes collaris* (LeConte).
Figure 27. Mandible of larva of *Endeodes collaris* (LeConte).
Figure 28. Pupa of *Endeodes insularis* (?) Blackwelder, lateral view.
Figure 29. Pupa of *Endeodes insularis* (?) Blackwelder, ventral view.
Figure 30. Pupa of *Endeodes insularis* (?) Blackwelder, dorsal view.





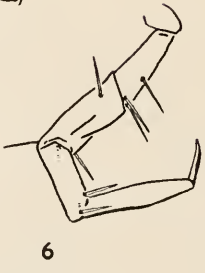


PLATE 14

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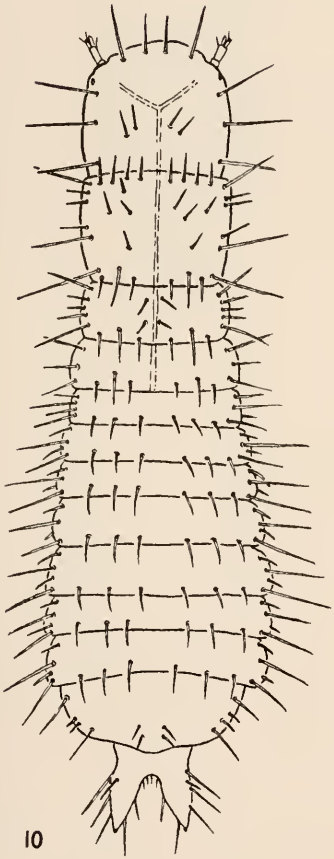

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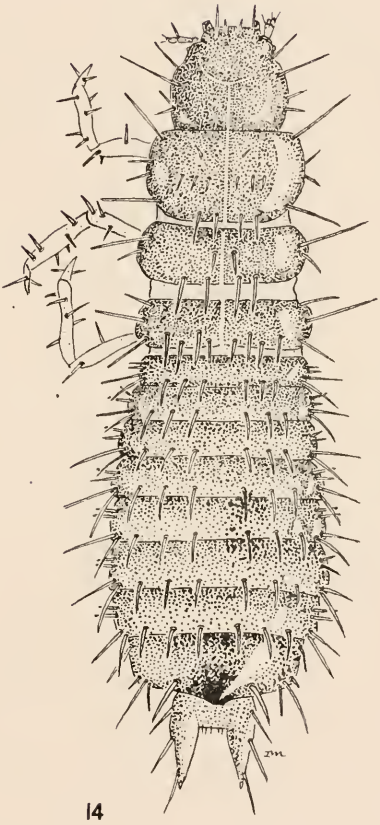

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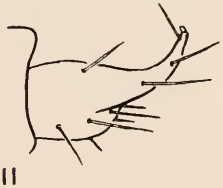

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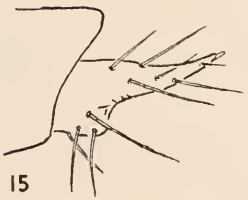

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PLATE 15

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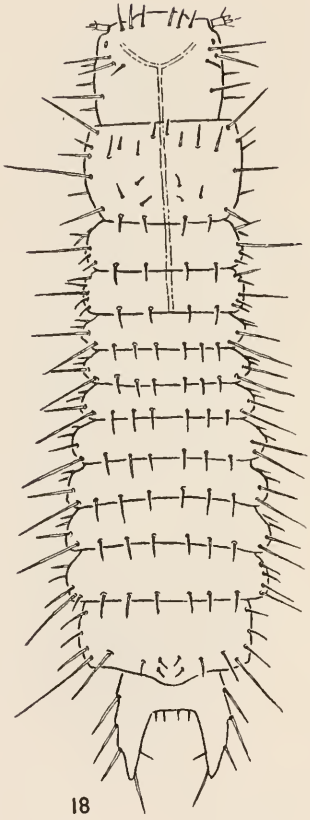
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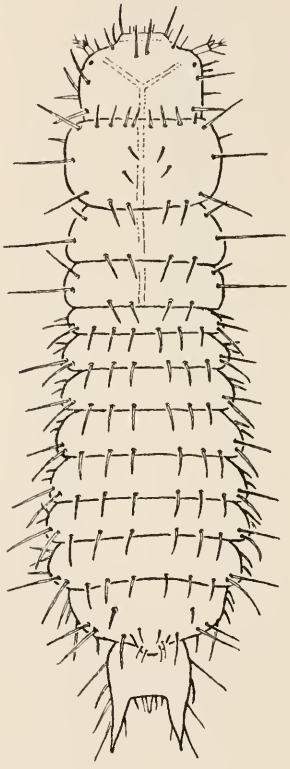
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PLATE 16

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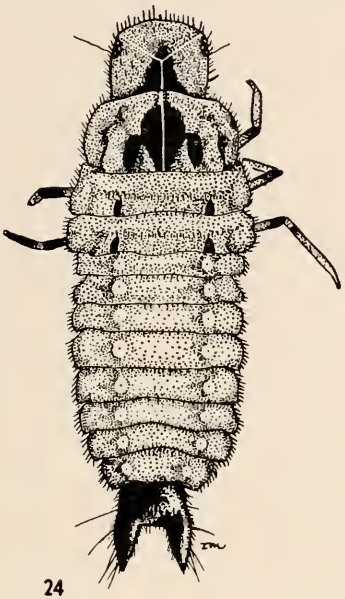

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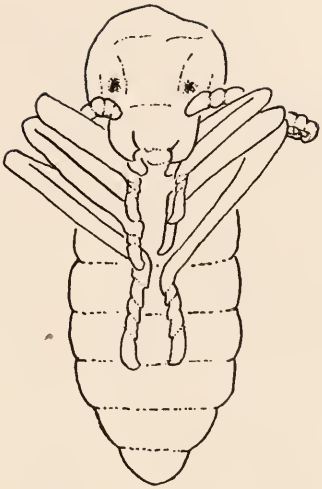

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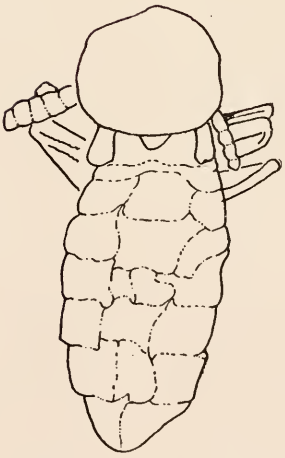

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PLATE 17

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TRANSACTIONS

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SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII, NO. 12, PP. 231-262 PLATES 18-21

A NEW SPECIES OF MEGATHYMUS FROM BAJA CALIFORNIA, MEXICO

(Lepidoptera : Megathymidae)

BY

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SAN DIEGO, CALIFORNIA

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Plate 18

Upper Panel

Agave shawii Engelmann (*orcuttiana* Trelease) as it grows on the hills east of San Simón, Baja California. This is the host plant of *Megathymus comstocki*. The photographs from which the cuts were made, were reproduced from kodachromes taken by the author in the type locality of the new species.

Lower Panel

Typical group of *A. shawii* in the type locality of *Megathymus comstocki*. The relatively large size of the agave will be particularly noted. E. P. Chace at right, in readiness for collecting.

A NEW SPECIES OF MEGATHYMUS FROM BAJA CALIFORNIA, MEXICO

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INTRODUCTION

In the literature covering the Lepidoptera of Baja California, Mexico, there is little information on the megathymids. No *Megathymus* is listed in the Rindge 1948 paper, "Rhopalocera of Lower California." Dr. Cockerell's 1941 article, "Observations on Plants and Insects in Northwestern Baja California, Mexico, with Descriptions of New Bees," does not list any species of these interesting butterflies. In Dr. Hoffmann's, "Catálogo de Lepidópteros Mexicanos" of 1941, two species, *M. yucca navajo* Skinner and *M. stephensi* Skinner are given as occurring in Baja California. No exact locality is mentioned for either. I believe that the species are listed because their known occurrence in adjacent San Diego County, California, suggested a probable extension of range south of the international boundary.

In late August of 1953, the new megathymid described in this paper was discovered during a collecting trip with Mr. Laurence M. Huey, Curator of Birds and Mammals, San Diego Society of Natural History, Mr. Huey's wife, Mrs. Eva Huey, and Mr. Wesley Farmer of the Museum's Activities Department. We camped about two miles northeast of San Simón on the north side of San Simón (Santa María) River Valley. Dr. Carl L. Hubbs of Scripps Institution of Oceanography, who has often visited the region states that "the locality is about six miles east-southeast of the present village of San Quintín, which is located at the old mill, approximately three miles northwest of the old, now abandoned village of San Quintín." Both localities are on Bahia San Quintín. (Lat 30° 23′ N).

Mr. Farmer and the author succeeded, after much effort, in collecting a series of ten males and two females. The butterflies are strong and rather erratic flyers and to net one requires considerable stalking and agility. The specimens captured were in very poor shape by the time they were quieted by the cyanide killing-jar fumes. Anxious to obtain a longer series and more perfect specimens before describing

this new insect, the author made two return trips to the vicinity, one in December, 1953, and the other on August 11, 1954. He planned to collect the immature stages in the host plant and to rear the imagines. These could be killed before they had damaged themselves. No larvae or pupae were obtained on either trip. The adult butterflies were not expected to be on the wing on the December visit but it was hoped that some could be captured on the August 11th trip. Apparently this was too early. On this latter trip, the author was accompanied by Mr. Jerry Powell and Mr. F. James Rohlf, both enthusiastic entomologists. If the butterflies had been on the wing, some certainly would have been seen.

Early in September, 1955, the author, accompanied by a group of his entomological friends, returned again to the vicinity of the first collection of the new species. On September 6, his cousin, Mrs. Marion Beckler, an author of children's books, accompanied him down to Colonia Guerrero where they met two other members of the expedition, Mr. Ian Moore, Research Associate in Coleoptera at the San Diego Natural History Museum, and Mr. Joe McKenney, a pre-medical student at Stanford University. Mr. McKenney had succeeded in netting one of the butterflies at Camalú, several miles north of Colonia Guerrero and almost thirty miles north of the original locality. The next day, these four went south to Laguna Santa María where they spent part of two days and one night collecting. No megathymids were taken and none were expected.

On September 8, the four members of the expedition returned to San Simón, up the river valley at the base of the low, flat-topped hills, about three miles northeast of the ponds and beach. Mr. Moore then headed north to the United States. The three remaining members of the early group, while exploring the hillsides and flat mesas above the store at San Simón, captured several specimens of the new butterfly. That evening the party was joined by Dr. Francis X. Williams, Research Associate in Hymenoptera at the Museum, his wife, Mrs. Louisa C. Williams, Dr. John Adams Comstock, a Director of the Society of Natural History, the Museum's Editor of publications, and an experienced collector of *Megathymus* larvae and pupae, and Mr. E. P. Chace, Curator of Conchology and Marine Invertebrates of the San Diego Society of Natural History. The party camped about two miles northeast of San Simón on the north side of the broad San Simón River valley near an old eucalyptus tree on the floor of a branch cañon.

On the next day the entomologists proceeded to work the agaves growing north of the camp site, for larvae and pupae. We found that with an ax and machete, we could cut the long horizontal trunk of each plant below the green basal leaves. We then proceeded to tip the plant over so that the sharp terminal spines on the leaves were forced into the ground below. This anchored the plant in an up-side-down position. The entomologists and the conchologist then removed one leaf at a time from the stalk, examining each leaf, in turn, for indication of megathymid infestation. The infested leaves were placed in pillow cages made of copper screen-wire cloth. These were sealed by folding over the screen at the open end and running a piece of wire through the fold to keep it closed. The infested leaves were brought back to the United States under special permit from both Mexican and American Governments and the immature stages reared through to imago by Dr. Comstock. Later in the day Mr. Paul Arnaud, a staff member of the California Bureau of Plant Quarantine, based in San Diego, and Mr. Arthur Lee of the San Diego City and County Health Department joined the party. The combined group collected a fine series of specimens constituting most of the types of the new species.

Acknowledgments

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PLANT ASSOCIATION

Both north and south of the broad, sandy Arroyo San Simón are high, flat-topped rocky mesas covered with extensive growths of a century plant or maguey, which is the host plant of the new butterfly. We have heretofore been designating this plant *Agave orcuttiana* Trelease, the type of which was collected at San Quintín in 1886 by Charles Russell Orcutt, for whom the species was named by Dr. William Trelease in his monograph on "The Agaves of Lower California."[1] This name was considered valid by Alwin Berger in his "Die Agaven" in 1915.[2] Dr. L. H. and Ethel Zoe Bailey listed *Agave orcuttiana* Trelease, in their 1941 "Hortus Second." In Dr. Bailey's 1935 "Hortus" there is no listing of *A. orcuttiana* but in his 1944 reprinting of his "Encyclopedia of Horticulture" he gave *A. orcuttiana* under his heading, *Agave shawii,* as a related species. Dr. Ivan M. Johnston in his 1924 report on the botany of "the Expedition of the California Academy of Sciences to the Gulf of California in 1921",[3] stated that in his opinion "*Agave shawii* Engelmann includes *A. sebastiana* Greene, *A. orcuttiana* Trelease, *A. pachyacantha* Trelease, and *A. goldmaniana* Trelease." Dr. Reid Moran and Dr. George E. Lindsay, in their 1951 paper on "San Benito Island"[4] stated that, "in view of the intergradation that apparently exists, some of these species seem rather weak." In conformity with these later opinions we are

[1] Rep. Mo. Bot. Gard. 22 : 47, 1912
[2] Gustav Fischer, Jena, 1915. p.171.
[3] Proc. Calif. Acad. Sciences 12 : 1003. 1924
[4] Desert Plant Life, 23 : 83. 1951

considering the species of agave occurring at and near San Quintín as only a non-specific variation of a widely ranging species, *Agave shawii* Engelmann.

The high mesa country north of the San Simón River Valley is dissected by many steep-sided gullies and small cañons. These drain southeastward and enter the main valley almost at right angles. Many of these cañons have a number of forks as they penetrate the great mesa and drain it during the infrequent rains. By following up one of these forks to its source one finds himself on a flat-topped, rock-covered plateau that extends almost level for miles, and is covered with little vegetation.

The agave is the dominant plant of the cañon sides and hill tops near the large valley. (See plate 18.) It seems to prefer to grow in rocky ground along with PITAHAYA AGRIA, *Machaerocereus gummosus* (Englemann) Britton and Rose, and COCHAL, *Myrtillocactus cochal* (Orcutt) Britton and Rose. GRAY BUR-SHRUB, *Franseria chenopodiifolia* Bentham, and the low growing CALIFORNIA BOX-THORN, *Lycium californicum* Nuttall also clothe the steep rocky sides of the branch cañons. On the flat-topped mesas near the main valley are numerous specimens of the BRANDEGEE WREATH CACTUS, *Neomammillaria brandegeei* (Coulter) Britton and Rose, and a low, flat barrel, FORD BISNAGA, *Ferocactus fordii* (Orcutt) Britton and Rose. Here also is found PARRY BUCKEYE, *Aesculus parryi* A. Gray, several species of CHOLLA, *Opuntia* spp., SAWTOOTH GOLDENBUSH, *Haplopappus squarrosus* Hooker and Arnott, and CLIFF SPURGE, *Euphorbia misera* Bentham.

The floor of the side cañon is covered with large shrubs of RICH BOX-THORN, *Lycium richii* A. Gray, LAUREL SUMAC, *Rhus laurina* Nuttall, PALMER GOLDENBUSH, *Haplopappus palmeri* A. Gray, DESERT FRAGRANCE, *Hymenoclea monogyra* Torrey and Gray, and SHAD-SCALE, *Atriplex canescens* (Pursh) Nuttall. Also, not far south of camp are several fine clumps of RUSH MILKWEED, *Asclepias subulata* Decaisne, and that very beautiful cactus of Baja California, CABEZA VIEJA, *Lophocereus schottii* (Engelmann) Britton and Rose.

Laboratory Procedure

Briefly, the laboratory procedure used in this study of the new species is as follows. The antenna, palpus, and legs of one side of the holotype were removed and studied and drawings made thereof.

The antenna was drawn with scales in place and then glued back on the head. An antenna of one of the paratypes was removed and soaked for twenty-four hours in each of the following: 10 per cent sodium hydroxide solution, water, 95 per cent alcohol and, finally, xylene. Later it was mounted on a microscope slide in clear Canada balsam. This procedure removed the scales and slightly distorted each of the segments, but every joint in the antenna became exposed and easy to count and study. The same method was used on the labial palpus and in the study of male and female genitalia. A right palpus was removed from one of the paratypes and, after descaling dry, was studied to see what effect the soaking in solutions had produced on this appendage of the holotype, and then was drawn from three aspects.

The head was removed from one of the paratypes, making it possible to lift the patagium from the prothorax. This was descaled after the arrangement of scales had been studied. The tegula was removed from the mesothorax at base of the fore wings and the arrangement of the scales noted. It was then descaled.

The legs removed from the holotype were studied with scales in place. They were then descaled and studied from both the upper and lower aspects in the dry state. (Plate 19.) The claw-bearing segment of the tarsus from one of the paratypes was mounted on a slide after it had been expanded by the same method used with the palpus (Plate 19). The wings from the right side of one of the paratypes were removed, descaled dry, and then mounted between two glass slides. Later these were projected by using a two by two inch slide projector with the mirror of the camera lucida reversed, so that they appeared projected downward on drawing paper on the surface of the table and could be accurately traced, after which the light maculations of holotype male were drawn in, free hand, on this drawing in approximate position.

The genitalia were removed from the holotype male, the allotype female, 10 male and 4 additional female paratypes. After being carried through the solutions as used with the labial palpus, they were mounted on slides in balsam. Well slides were used for the male genitalia. Later, camera lucida drawings were made. Details were studied directly under the high power of the compound microscope and added to the camera lucida drawings.

Megathymus comstocki, new species

Plate 21, figures 1 to 8.

Type Specimens

The series examined consisted of forty-two specimens: holotype male, allotype female and forty additional paratypes, of which twenty-three were males and seventeen were females.

Table 1. Data on Type Series of **Megathymus comstocki**

All from Baja California, Mexico; collected, except as indicated, in 1955. All specimens other than the holotype are paratypes.

Locality	Collector	Date	Type Designation and specimen No.	Males	Females
2 miles NE. of San Simón	McKenney	Sept. 10	Holotype	1	—
Do.	Comstock	Sept. 9	[1] Allotype (♀ 1)	—	1
Do.	Harbison	Sept. 9	♀ ♀ 2 - 5	—	4
Do.	McKenney	Sept. 9	♂ ♂ 14, 17, 19 - 22,	6	—
			♀ 11.	—	1
Do.	Comstock	Sept. 9	[1] ♀ 8	—	1
Do.	Comstock	Sept. 9	[2] ♀ 15 (malformed)	—	1
Do.	Comstock	Sept. 9	♀ 9	—	1
Do.	Williams	Sept. 9	♂ 23;	1	—
			♀ 18	—	1
San Simón	Harbison	Sept. 8	♂ ♂ 2, 3	2	—
Do.	McKenney	Sept. 8	♂ ♂ 13, 15, 16, 18	4	—
			♀ ♀ 10, 12, 13, 16, 17	—	5
Mesa S. of San Simón	Harbison	Aug. 31, 1953	♂ ♂ 1, 6	2	—
Do.	Farmer	Do.	♂ ♂ 4, 5, 7 - 12;	8	—
			♀ ♀ 6, 7	—	2
Camalú	McKenney	Sept. 6	♀ 14	—	1

Holotype male* and allotype female—are in the type collection of the San Diego Society of Natural History. Paratypes (see table 1) have been deposited thus: American Museum of Natural History, ♂ 22, ♀ 3; California Academy of Sciences, ♂ 23*, ♀ 18*; Los Angeles County Museum, ♂ 21, ♀ 17; National University of Mexico, Instituto de Biologia, ♂ 20, ♀ 5; Dr. J. A. Comstock, ♂ 18, ♀ 8, ♀ 9*; Dr. H. A. Freeman, ♂ 19, ♀ 16; Mr. M. J. McKenney, ♂ 13, ♂ 14, ♂ 15, ♂ 16, ♂ 17, ♀ 10, ♀ 11, ♀ 12, ♀ 13, ♀ 14. Paratypes ♂ 1*, ♂ 2*, ♂ 3, ♂ 4, ♂ 5*, ♂ 6*, ♂ 7*, ♂ 8*, ♂ 9*, ♂ 10*, ♂ 11*, ♂ 12, ♀ 2, ♀ 4, ♀ 6*, ♀ 7*, ♀ 15* have been retained by the San Diego Society of Natural History.

[1] Pupa collected in host plant; emerged Sept. 12, 1955

[2] Pupa collected in host plant; emerged Sept. 27, 1955

*Microscope slide made of genitalia; should be kept with mounted specimen.

HOLOTYPE MALE

The Head and its Appendages

The head, including the compound eyes, is as wide as the mesonotum between the attachments of the forewings. The eyes are large: their length as viewed from above is about equal to the shortest distance between their bases across the vertex of the head just above the attachment of the antenna. The eye is beveled to the attachment to the head and lacks ommatidia in this smooth, shining black, scaleless, ringlike area. Some of the scales of the head extend laterally over this area so that, in life, the beveled area is not easily seen. The seeing surface of the eye is evenly rounded and is composed of numerous blackish ommatidia. The bases of the antennae are far apart; in fact, as viewed from above, the outer side of the basal segment rests against the beveled edge of the compound eye. The antenna has 35 segments. The basal segment bears a comblike structure of 4 stiff black bristles that extend out laterally over the compound eye. It is about as long as wide. Succeeding segments lengthen gradually until they become about twice as long as wide just before the club. The club begins with joint 21, reaches its widest part, as viewed from above, at joint 26 and then tapers quite abruptly to its end. The segments near the head have a narrow basal ring of white scales that cover about one-sixth the length of the segment when viewed from above. This ring becomes much wider beneath, covering from one-half to five-sixths of the length of the segment. The part of each segment that is not covered with white scales is clothed with dark brown scales. The white scales are more extensive in the club. The central, lower surface of the club is covered almost completely with white scales, but at the tip there is a heavy admixture of brown. The last segment is completely covered with these brown scales.

Attached to the underside of the head is the well-developed light brown, and heavily chitinized proboscis which, if extended, would reach the base of the abdomen. It is tightly coiled like a watch spring when the insect is not feeding. Striae transversely encircling the proboscis almost suggest a fine annular structure. On each side of the proboscis and fastened to the lower side of the head capsule is the three-jointed labial palpus. The first joint of this structure is small, and fastens the appendage to the head capsule. It extends downward and forward from the point of attachment, and then bends upward. The second joint is about two and one-half times the

length of the first segment and stands erect above it on either side of the coiled proboscis. The inner surface of this appendage is flattened so as to fit snugly in place against the proboscis. The outer surface is evenly curved and rests against the beveled area of the compound eye. Scales on the inner surface of the second joint of the palpus are flattened and white, and each usually has three or four sharp teeth at the distal edge. They are appressed to the surface of the joint and their distal free ends project upward. The segment viewed from the front is clothed with toothed scales, in an admixture of white and brown. The side of the palpus that rests against the compound eye is covered with flattened, toothed white scales and long dark brown hairlike scales. The very small third segment is about one-seventh as long as the second segment and is clothed densely with more or less erect scales. The vertex of the head also is covered with an admixture of vertical scales.

The Thorax and its Appendages

The pronotum is covered with brownish scales that tend to have their free edges rearward. The mesonotum bears a pair of platelike structures, (the tegulae), between the forewings at their attachment. These are densely covered with large scales, which have their distal free end caudad. Many of these scales are very long and hairlike. They are light brown or yellowish white. The under surface of the thoracic segments is clothed with an admixture of linear and hairlike white scales that tend to have their free ends caudad.

Wings of Holotype

Upper Surface

Primaries.—The forewings are mainly covered with dark brown appressed overlapping scales. The free end of each scale lies toward the outer margin of the wing. The scales cover the entire surface of the wings. They densely clothe the very heavily chitinized veins as well as the membranous surface between. The exposed length of surface of each scale is usually about twice the width. There is considerable variation, especially toward edge of wing and just inside the fringing scales, where usually the exposed length is about equal to the width. Near the base of the wing between the fork of vein Cu_2 and A_2 and near vein A_3 are numerous long hairlike yellow scales similar to those covering adjacent parts of the thorax and abdomen. The light maculations on the primary are composed of yellowish white scales similar in shape to the brown ones covering the main surface of the wing.

A small cell spot occurs just caudad to the fork of R_2. Of the four subapical spots, the first is located near the margin of the wing between R_2 and R_3, the second lies diagonally behind this, between R_3 and R_4; the third directly behind the second, between R_4 and R_5, some distance internal to the apex of the wing; and the fourth and largest is diagonally in line with subapical spots 1 and 2; it lies between veins R_5 and M_1. The rather small and indistinct extra-discal spots lie respectively between M_1 and M_2 and between M_2 and M_3. They are parallel to the outer margin of the wing and are nearer to it than are the spots of the discal band. The discal band is made up of four distinct spots. The first lies between M_3 and Cu_1 and is the largest. It is rounded and occupies about one-half of the distance between veins. The second discal spot lies caudad of the first, between Cu_1 and Cu_2. Two very small spots lie between Cu_2 and A_2. These actually seem to represent one spot divided by the fold that represents vein A_1. The fringes are alternately dark brown and white. The scales making up the fringe are about four times as long as wide, with the outer edges toothed.

Secondaries.—The entire upper surface is almost completely covered with small dark brown scales. In addition, the bases of the wings, out as far as the maculations, are covered with an admixture of dark brown and yellowish hairlike scales. The maculations are formed of small yellowish white flattened scales similar in shape to the small brown scales. Between Sc and R and nearer to the base of the wing than any other spot is a large indistinct maculation. Diagonally caudad of this spot, between R and M_1, is a second indistinct light area. A discal band of five spots occurs some distance internal to the margin of the wing. The last of these spots, between Cu_2 and A_2 is actually a double spot. None of the spots occupies the entire space between veins. The fringe along the edge of wing is made up of white and dark scales. The dark areas are located where the principal veins reach the edge of the wing.

UNDER SURFACE

Primaries.—Most of the under surface of the wing is covered with small dark brown appressed scales, having their free tips toward the outer margin of the wing. The light maculations show more plainly on the lower side than on the upper. The cell spot is obsolete. The four subapical spots are very distinct and occupy the same position that they do on the upper surface. This is also true of the two extra-discal spots and the three spots that make up the discal

band. The last spot of this band is distinctly divided through the middle. The tip of the wing has an over-scaling, of toothed white scales, that produces a frosted appearance. The fringe along the outer margin of the wing is composed of two layers of scales.

Secondaries.—The under surface shows the same discal band of five yellowish white spots extending from vein M_1 to vein A_2. Internal to the discal band are faint light patches, one between R and M_1, and a second between Sc and R. Another light patch occurs between Cu_2 and A_2, caudad of the fork of the Cu_2 vein. The lower surface is overlaid with toothed white scales and hairlike scales. This gives the under surface a frosted appearance. The double-row nature of the black and white fringe shows plainly along the margin of the wing.

Expanse of wings of holotype male, 40.2 mm.

Legs of Holotype

The femur of the foreleg is long and laterally flattened; white and gray overlapping scales densely cover the top edge and also the two sides and are markedly appressed to the surface. A number of hairlike scales occur along the outer lower edge of the femur. Jointed to the distal part of the femur and, at rest, bent backward, jack-knife fashion, is the shorter tibia. The tarsus is five jointed.

The femur of the second leg is longer than that of the foreleg and about equal to the length of the next segment, the tibia. This segment is laterally flattened and is covered with hairlike scales on the inner surface next to the body. This joint, at rest, extends caudally. The tibia is clothed with gray and white scales. There is a five jointed tarsus.

The very short, laterally flattened femur of the third leg is clothed on the inner side, next the body, with dark hairlike appressed scales that extend downward beyond the lower edge of the segment, forming a fringe wider then the femur.

On its outer side are flattened whitish scales. The tibia is much longer than the femur, almost as long as the femur of leg two. The tibia is clothed with flattened and hairlike scales, extending downward over the basal segment of the tarsus. The inner side bears a dense covering of flattened scales.

Tarsi

The five-segmented tarsus is covered with flat imbricated scales. The final row of scales on the last tarsal segment extends over the claws and actually hides from view the truncate pulvillus. Stiff spines

arm the inner and lower side of the tarsus. Scattered spines on the upper side are visible only when the imbricated scales are removed.

THE ABDOMEN AND ITS APPENDAGES

The basal segments are complete rings. Segments VIII, IX and X are modified into the male genitalia and are covered with flattened, toothed, light brown scales overlaid by long yellowish hairlike scales. The dense covering of scales and their extension rearward makes it difficult to see the male genitalia until the scales are removed. Segment IX is telescoped forward into the ringlike segment VIII, and is composed of the heavily chitinized tegumen, the narrow ringlike vinculum, and the bladelike, forward-pointing saccus. The notum of segment X is the uncus and forms two downward-bent hooks. Viewed from beneath, it is very broad and heavily chitinized at the tip. Its tip is nearly half the breadth between the wide part of the uncus, about two-thirds of the way rostrad to its base. This breadth is about one-third of the length of the segment. It is slightly bifid. The sternite of this segment X constitutes the upward bent hooks, the gnathos. These are rounded basally and bent up with an even curve on either side of the anal opening. Fastened to the vinculum are two clasping organs, which are thought to represent abdominal legs. These valvae, harpes, or claspers (depending on the authority followed) are slightly more than three times longer than broad. They have two basic parts, the lobe above and the blade below. The blade extends into a sharp up-pointed end. This is the cucullus of the valva. Various teeth occur along the edge, from the pointed tip rostrad. The upper edge of the lobe is the costa of the valva, and the lower edge of the blade, forming a heavily chitinized brace-like thickening, is the sacculus. A large process, the proharpe (using the Barnes and McDunnough term) is rostrad from the tip of the blade at a point where the outer part of the lobe touches the blade. This structure is heavily spined and has a basal fork that is very distinctive in the new species. The aedeagus is held in place in the cavity between the valvae by an annulus, a transverse plate with encircling upward-pointing lateral arms. The aedeagus is a chitinized tube-like structure with a flaring tip. This, the vesica, has, on each side, ten cornuti.

ALLOTYPE FEMALE

THE HEAD AND ITS APPENDAGES

The head, including the compound eyes, is about two-thirds the width of the mesonotum between the wing bases. The compound

eyes are smaller than in the male. Their length, when they are viewed from above, is about one-third less than the distance between their bases, across the vertex of the head above the attachment of the antennae. The flattened linear scales on the front below the antennae stand more or less erect. The toothed brownish scales of the top and back of head tend to lie forward thickly over the base of the antennae, so that it is impossible to see the basal joint without their removal. The black spinelike scales forming the so-called eyebrow are well developed in the female. The antenna is ringed narrowly with white at base of each joint, becoming wider on inferior surface. The under side of club is white; the upper side, brown. The labial palpus is clothed densely with white, sharply-toothed, upright scales. The proboscis seems to be similar to that of the male.

The Thorax and its Appendages

The pronotum is covered with a dense thatch of flat, toothed scales, each of which tends to have its free end appressed to the surface of the segment. The mesothorax bears two large platelike structures, the tegulae. These are covered with light brown acicular scales. Mixed with these are a few darker, flat scales. The number and length of the hairlike scales increase on the metanotum.

WINGS OF ALLOTYPE

Upper Surface

Primaries.—Most of the dark brown scales covering the wing are flat and have striae running their length. Scales of this type cover most of both surfaces of the wing, and are basic. Hairlike scales of light golden color cover the base of the forewing. The maculations are similar to those of the male but are much more extensive and of a richer, brighter color. The four-sided cell spot is caudad from the costal edge of the wing a distance equal its width. Its front edge is straight and parallel to this margin. The side toward the apex of the wing is concave to a point. The rear margin of this spot bows downward. The fourth margin is concave to its juncture with the straight front edge. The first spot of the subapical band is very indistinct. The second, third, and fourth are about equal in size and are arranged diagonally across the wing tip. The extra-discal spots of the female are about four times the size of those of the holotype male and are parallel to the outer margin of the wing. The first spot in the discal band between M_3 and Cu_1 is nearly rectangular and in width covers most of the interspace between these veins. It is twice as long as wide and of the two ends the outer is convex, the inner concave.

Spot two of the discal band is five-sided. The straight front edge of this spot is of about the same length as the rear edge of spot one. The outer edge of spot two becomes slightly diagonal outward. The rear side is nearly straight. The fourth side runs diagonally toward the body of the insect to contact with the fifth side. The fifth side is slightly concave. This spot is about twice as long as broad. Spot three of the discal band lies between Cu_2 and A_2. It is very irregularly four-sided. The front edge of this spot on the right forewing is nearly straight; the outer side tends to be undulate; the rear side is straight; the inner or fourth side is again undulate. In the left forewing as a variation, the undulations of the two sides are carried to a point, where the spot forms a very thick letter Z reversed. The spot is twice as long as wide, crossing the entire interspace between the veins. The fringe along the outer edge of the wing is made up of dark and light, flattened, toothed scales. Each scale is about four times as long as wide.

Secondaries.—Dark brown scales are basic as in the primaries. There is a much more extensive area of long golden hairlike scales, extending almost to the row of discal band spots. Between R and M_1 is an orange-yellow spot, indistinct because overlaid by long brown hairlike scales. Diagonally behind this, between M_1 and M_2, is the first spot of the discal band. This is of about the same size as in the holotype male. There appear to be six of these discal spots but I believe that the fifth spot is divided in two parts. On the underside of the wing these two spots tend to be fused. The black and white fringe along the edge of the wing is a very striking feature.

UNDER SURFACE

The primaries have the same maculations as on the upper surface. The cell spot tends to be double, comprising a very small spot, followed by a large light maculation. The apex of wing bears an overlay of white scales. The secondaries beneath have an extensive overlay of white scales that more or less hide the maculations. Spots equivalent to those of the upper surface can be found if carefully sought but they average smaller. Discal spot five appears as one large spot, thus differing from its equivalent on the upper surface, where it appears to be double. The fringe along the outer edge of the wing is alternately white and dark.

Expanse of wings of allotype female, 53.3 mm.

LEGS OF ALLOTYPE

The legs are similar to those of the holotype male.

The Abdomen and its Appendages

The abdomen of the allotype female is much longer than that of the holotype male and is distended with eggs. It is covered densely with overlapping scales. The female genitalia* comprise vaginal and postvaginal plates and the ovipositor. The ostium or orifice of the bursa copulatrix is on the caudal (posterior) edge of the vaginal plate. Mating with the male is through this opening. The vaginal plate, measured medially from its posterior edge above the ostium to its anterior margin between the rounded inner end of the lateral fold, about equals two-thirds the distance between the posterior points of that structure. This lateral fold forms a nearly straight inner edge. Its outer edge is decidedly bowed outwardly. The posterior end is about in line with the anterior margin of the ostium or opening of the bursa, and diverges outwardly. The anterior or rostrad end of the lateral fold is rounded and converges medially. The distance between the rounded anterior ends of the lateral fold is about one-half of the distance between the pointed posterior ends.

A convex lens-shaped sclerite rests medially with its inner side against the pointed end of the lateral fold. The outer point of the sclerite is diagonally outward. The inner point is directed inward and reaches the level of the posterior margin of the medially placed orifice. Directly posterior to this are the structures called by Barnes and McDunnough the alae.

From the posterior margin of the orifice a ribbon-like band curves diagonally forward and outward until it reaches the level of the anterior edge of the orifice. This brings it about half way to the pointed end of the lateral fold. Here it apparently is turned up and over. It extends rearward to the inner point of the convex lens-shaped sclerite. Because of the apparent twisting of this band in the middle, an isosceles-triangle-shaped dark spot appears at the point of the twist, with its apex pointing rearward. The band again curves over on itself and ends in a flaring, only weakly chitinized funnel-shaped structure.

The anterior margin of the plate between the rounded ends of the lateral fold is sinuous. The medial part of this edge is bowed forward. On each side of this, and connected to the broad end of the lateral fold, the edge is bowed rearward. The outer curved edge of the lateral fold is margined with long hairs that extend outward

*The author accepts the terms for the female genitalia used by Barnes and McDunnough in "Revision of the Megathymidae," 1912, rather than those suggested by A. Diakinoff in "Lepidopterist News," 1954.

at right angles to the edge a distance of about half the width of the fold. The general surface of the plate between the folds is covered with many short bristle-like spines. These are placed in definite rows and form a beautiful pattern.

The oviporus is on the postvaginal plate. Through this opening the eggs are extruded. The postvaginal plate has a heavily chitinized fold along its anterior edge. This fold is bluntly crescent-shaped and is covered with short bristles. Behind this is a wing-shaped structure, which is emarginate medially on the posterior edge. It then bows outward and gradually tapers off to a point laterally. The oviporus is in the emarginate middle posterior part of the plate, which is covered with various types of spines. On either side of this area the covering spines become coarser and more numerous. Beginning with this area, medial to the tapered outer part of the plate, the spines become very heavy and several may originate from a single spot on the surface. The spines lie with their unattached tips pointing caudally.

The lobes of the ovipositor at the end of the abdomen are retracted into a cavity by the telescoping of several segments. They are ear-shaped and are covered with long bristle-like spines on their outer surfaces. In the allotype slide they are flattened out. Usually, on the slide they stand in vertical position, suggesting the ears of an alert rabbit.

STUDY OF THE PARATYPE SERIES

Appendages of the Head

Antenna

Certain structures were studied on paratypes that could not be examined on the holotype without complete dismemberment. An antenna was removed from a paratype, descaled and then run through sodium hydroxide, water, alcohol, and xylene. This expanded the segments. The antenna is composed of 35 segments, 20 in the stalk and 15 in the club. The basal 7 segments of the club are each progressively larger. The remaining 8 segments are each progressively smaller. (Plate 19, fig. 1B.)

Labial Palpus

The labial palpus of a paratype is shown in several aspects on Plate 19, fig. 2B, 2C, D. Note that the basal segment is as broad as the second and that the ultimate segment is very small.

The Thorax and its Appendages

The head of the paratype was removed and the prothorax

examined. On the upper part of the pronotum, covered with upright scales, are two reniform structures, the patagia, which are rather thin vertical extensions of the integument. They are readily removed and descaled (Plate 19. fig. 3). Another structure of interest is the platelike outgrowth of the mesonotum at the base of each primary. This structure, the tegula, has a long, rounded, bladelike extension caudad and a down-curved fore part that forms a shoulder cover. This plate is clothed heavily with long, grayish-brown flattened scales and numerous long hairlike scales. Denuded of scales it is illustrated on Plate 19, fig. 4. At present these structures are not considered as diagnostic in a study of the species of this genus, but on comparison, long series of slides of each species might show some significant differences.

The Wings

The descaled wings of a paratype did not show any distinctive venation. The maculations of the male and female wings vary somewhat in the series of specimens before the author. This is especially true of the cell spot of the primaries. In some specimens this is large and extensive; in others it is indistinct. The two extra-discal spots vary in size and shape. The discal band may contain four distinctly separate spots, or the last two (caudad) spots may be fused to form one. Only three paratypes in the series of twenty-three males show a distinct spot between A_2 and Cu_2, about halfway from the base of the wing to its outer margin. If it were not for these exceptions and for the fact that about three-fourths of the females examined show the spot, this would be a good character for separating this from related species. The secondaries have a discal band of five spots. The last spot tends to be double in some of the paratypes.

In the wing maculations of the female paratypes all spots are more extensive than in the males, but vary decidedly as to size and shape. The cell spot is seen in all eighteen female paratypes. The greatest difference is in the size and shape of the spots composing the discal band of the primaries. Each spot reaches almost completely across the interspace between the veins. In the allotype female (paratype ♀ 1) spots 1 and 2 of the discal band are much broader than long. Spot 3 tends to be shaped like the letter Z. In some of the females, spots 1 and 2 become almost square. Spot 3 varies to almost the double condition found in the holotype male. The spots in the discal band on the secondaries vary from six to five. In twelve

of the eighteen paratype females there is a spot between A_2 and Cu_2 about half way from base to outer margin.

TARSUS

The tarsus (Plate 19, fig. 6A) is quite distinctive. The pulvillus is truncate and slightly emarginate. It is dark at the tip. The paronychium is a broad ribbon-like structure with ciliated edges two-thirds the length of the claws. The claws are only slightly curved at the tip.

GENITALIA
(Plate 20)

To determine the variation in the paratypes, slides were prepared of the genitalia of nine males and four additional females. The uncus of each paratype was studied from below before it was mounted permanently on a slide. The genitalia of paratypes ♂ 7 and ♂ 11 were placed so that the uncus and tegumen would remain with ventral surface exposed. The other seven slides were assembled with the uncus showing the lateral aspect. In the holotype male, after the underside of the uncus had been studied and drawn, this part was laid on its left side.

Little variation was found. The valvae vary slightly in shape. In some paratypes the cucullus is drawn out into an upcurving point, in others it is more blunt. The proharpe tends to show a basal arm or branch on its rostrad side where it is attached to the blade. Spines similar to those on the main proharpe are found on the basal arm and also point with free end upward. The branching of proharpe is characteristic and uniform in this species.

The genitalia of the females are less uniform than those of the males. The author made a slide of the genitalia of the allotype female, a specimen collected as a pupa and reared. Slides were also made of three other female paratypes, collected in the field as adults. These had probably already mated. The allotype had had no opportunity to mate as no males were reared; therefore the author suspected that the observed differences might be attributed to her virginity. A second slide of a reared, unmated female was made late in the study. This latter slide did not agree completely either with the allotype or with any of the other paratypes.

COMPARISON OF THE NEW SPECIES WITH RELATED SPECIES

The new species of megathymid was compared with other members of the agave-feeding section of the family. When viewed from below,

the male unci of *M. stephensi, M. mariae, M. polingi,* and *M. comstocki* are equally broad at tip, about one-fourth broader than in *M. neumoegeni,* as indicated in the illustration in the Barnes and McDunnough monograph. *M. stephensi* apparently should not be considered a subspecies of *M. neumoegeni.*

Megathymus stephensi Skinner

One might expect that the nearest relative of the new *Megathymus* would be *M. stephensi,* another agave feeder found in the desert region of San Diego County just north of Baja California, but the maculations are quite different and the male and female genitalia do not indicate a close relationship. Also the host plants of the immature insects are very distinct.

In the male of *M. stephensi* spot 3 of the discal band is not double in the forewing and the spot between A_2 and Cu_2, midway between the base of the wing and outer wing margin, is very distinct. On the secondaries, the discal band is much more irregularly placed than in the new species. The author checked the number of spots in the series of the San Diego Natural History Museum's collection and found that there are five in *M. stephensi.* In the original description, Skinner stated that "on underside secondaries . . . there is a large coalesced spot near the center of the wing and eight spots parallel to the margin." He evidently started with the spot inward from the costal margin and near the base of the wing and counted three spots before reaching the upper spot of the discal band. There are five spots in the discal band; adding these three, gives a total of eight. On the underside of the secondaries of *M. stephensi* there is a spot internal to the last discal, about halfway to the base of the wing. Forward of this, near the center of the wing, is an additional spot. Thus *M. stephensi* may show ten light maculations on the underside of the secondaries.

The new species is smaller in wing expanse; the largest male measures 46.5 mm; the smallest male of *M. stephensi* in the collection of the Museum, 50.0 mm.

Slides were made of the genitalia of two males and four females of *M. stephensi* taken near the type locality and these were compared with the slides of *M. comstocki.* The cucullus of the blade of the valva in these is more abruptly turned up and the space along the upper edge to the base of the proharpe is more irregularly spined. The proharpe of *M. stephensi* is not broad at the base as it is in the new species nor is it narrow at the base as in *M. neumoegeni,* but is

intermediate in width. There is no cephalic branch or even a tendency to branch in *M. stephensi.*

In the female genitalia of *M. stephensi* a heavily chitinized triangular extension runs diagonally from a plate located beside the ostium. The point of this triangle is extended to meet the inner side of the lateral fold slightly posterior to its middle. In the new species, the allotype slide shows the triangular area to be very small and it does not point forward toward the lateral fold; its apex is to the rear. The lateral fold of the Stephens' megathymid is sometimes extended around the edge of the plate so that the anterior point is directed rearward, a condition not observed in the new species.

Megathymus mariae Barnes and Benjamin

In respect to the light spots, *M. mariae* is intermediate between *M. polingi* and the new species. *M. mariae* has discal spot 3 wider than spots 2 and 1. In this character it differs from both *M. polingi* and *M. comstocki,* in which spot 3 is narrower than the two spots above. There is no tendency for this spot to become paired. In the new species, spot 3 is small and often divided by the very faint A_1 vein into two spots in the male. In the female this spot tends to be Z-shaped. The discal band of the secondaries in *M. mariae* is made up of five definite spots. In the new species there tend to be six.

The male genitalia of *M. mariae* are much more like those of *M. stephensi* than those of the new species. The cucullus of the blade of the valva is truncate and the space along upper edge to the base of the proharpe is even more irregularly spined than *M. stephensi.* The teeth are large and heavily chitinized. The upturned end of the cucullus is extremely heavily spined in *M. mariae.* The proharpe is also more heavily spined than in *M. stephensi* or *M. polingi.* Its basal breadth is about the same as in *M. stephensi,* much narrower than in the new species. It shows little tendency to become branched on its inner side as in *M. comstocki.*

In the female genitalia of *M. mariae* a heavily chitinized extension, at the level of the ostium, curves outward and then forward toward but not to the lateral fold, which is long and narrow. At its rostrad end, where the two pointed ends approach each other, the fold is bent so that these points actually are directed backward. This condition is quite different from that of *M. comstocki,* in which this part of the band is nearly straight and truncated. The margin of the plate between the curved ends of the lateral fold is deeply concave and

the edge is heavily chitinized. This margin in the new species is convex in the middle and concave on the two sides.

Megathymus polingi Skinner

On the basis of the study of the genitalia the author believes that the new species is more closely related to *M. polingi* Skinner than to the previously mentioned species.

However, the maculations of male of *M. polingi* are much larger than those of the male of *M. comstocki*. In *M. polingi* spot 3 of the discal band is large and single, completely crossing the interspace between A_2 and Cu_2. This spot is slightly narrower than spot 2. The spot in the interspace between A_2 and Cu_2, about half-way out from base of wing to the margin, is very distinct. This is often lacking in *M. comstocki*. The five definite spots in the discal band of the secondaries in *M. polingi* are larger than those of *M. comstocki*.

In the female of *M. polingi* the spots on the forewings are very large and entirely cross the interspaces between veins. This makes the wings truly banded. On the primaries of *M. polingi* the cell spot is broadly connected with spot 1 of the discal band and the two extra-discal spots form a band that connects broadly with spot 1 of the discal band caudadly and narrowly with subapical spots cephaladly. The subapical spots form a band to the costal margin of the wing. Thus the forewings appear to be crossed by a wide band of light color that is forked in its upper part, with the right fork bent inward to the costal margin of the wing when the right forewing was examined. The band between A_2 and Cu_2 is narrower than it is between Cu_2 and Cu_1 and between Cu_1 and M_3. In *M. comstocki* females the light scales are in separate spots rather than bands. None of the light scales are on the veins. Discal spot 3, between A_2 and Cu_2, is the narrowest of the three. Spot 1 does not come close to the cell spot.

The male genitalia of *M. polingi* is most like those of the new species. The cucullus of the blade of the valva is evenly curved upward and similarly spined. The spines along this edge are more regular and smaller in *M. comstocki* than in *M. polingi*. The base of the proharpe is broad and there is a tendency toward the development of a second branch at the inner base in *M. polingi*. There is an even greater tendency for the development of this branch in the new species.

The female genitalia of *M. polingi* have a heavily chitinized triangular extension from the plate beside the ostium. Its point is directed toward the upper part of the lateral fold but does not reach

its inner margin. The slide of the female *M. polingi* prepared from material loaned to the author by the Los Angeles County Museum shows this condition more plainly than does the illustration in the Barnes and McDunnough monograph. In the allotype of the new species the dark triangle does not point forward. The lateral fold in *M. polingi* is long and ends in a point at the posterior end. The cephalad end tends to be truncate. The fore edge of the vaginal plate on the margin where the lateral folds approach each other is strongly concave. In the new species the fold is similar but the edge of the plate between the truncated ends of the fold is convex in the median line, with an abrupt concavity on either side.

SUMMARY

The main purpose of this paper is to name a megathymid, believed to be new to science, *Megathymus comstocki,* captured first on the mesa south of the broad San Simón (Santa María) River valley, Baja California, Mexico, on August 31, 1953. Several return trips were made to the vicinity to collect a larger and more perfect series of this insect during late 1953, mid-August of 1954 and finally in early September, 1955. A series of 42 specimens was ultimately obtained. The holotype male and allotype female were studied in much detail and diagnostic structures illustrated, both photographically and by drawings. The paratypes of the new species were studied to determine variation. Other megathymids of the agave-feeding group were compared with this new species. Among the known species of the genus, *Megathymus polingi* Skinner appears to be the most nearly related.

A distinctive feature of the new species is the shape of spot 3 of the discal band in forewings, which tends to be very small and double in the male. The proharpe of this sex tends to have a basal arm, and is broad at base. In the female, spot 3 of the discal band of forewings is shaped like the letter Z. The structures on the two sides of the ostium in the allotype female are distinctive in that the triangular, heavily chitinized part has its apex pointing rearward.

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Explanation of Figures on Plates 19 and 20

Plate 19

Figures 1 to 6. Appendages of head and thorax.

1 A. Antenna of Holotype, upper and lower surface, scales in place.

1 B. Antenna of Paratype denuded and distended.

2 A. Labial Palpus of Holotype denuded and distended, first joint separated.

2 B. C. D. Labial Palpus of Paratype denuded but dry, front, inner and outer surface.

3. Patagium of Paratype romoved from prothorax and denuded of scales.

4. Tegula of Paratype removed from mesothorax and denuded of scales.

5. Wings of Paratype descaled and projected. Maculations of Holotype placed in relative position.

6 A. Claw segment of a paratype distended and denuded.

6 B. C. Legs of Holotype denuded dry, outer and inner surface Venation of wings, both Comstock-Needham (abbreviations) and British method (small numbers) used.

A.—Anal Vein; Cu.—Cubitus; Epi.—Epiphysis; M.—Media; Par.—paronychia; Pul.—pulvillus; R.—Radius; 8.—Subcosta; Seg. 5—Segment 5 of tarsus with attached claws and other parts; Sp.—Spur on Tibia.

Plate 20

Figures 1 to 3. Appendages of the abdomen. The genitalia.

1 A, B, C. Genitalia of Holotype male, lateral view from left side showing inner surface of right valva. Roman numbers refer to abdominal segment.

1 D. Annulus, front aspect.

2 Uncus and associated parts viewed from below.

3 Genitalia of Allotype female. Vaginal plate, post vaginal plate and ovipositor.

A—annellus; Ae—aedaegus; B—blade of valva; C—costa of valva; Cu—cucullus of valva; G—gnathos; L—lateral fold; Lo—lobe of valva; Opr—lobe of ovipositor; Pvp—Post vaginal plate; P—proharpe; S—saccus; S1—sacculus of valva; T—tegumen; U—uncus; Vp—vaginal plate; Vo—vaginal oriface; Ve—vesica; Vi—vinculum.

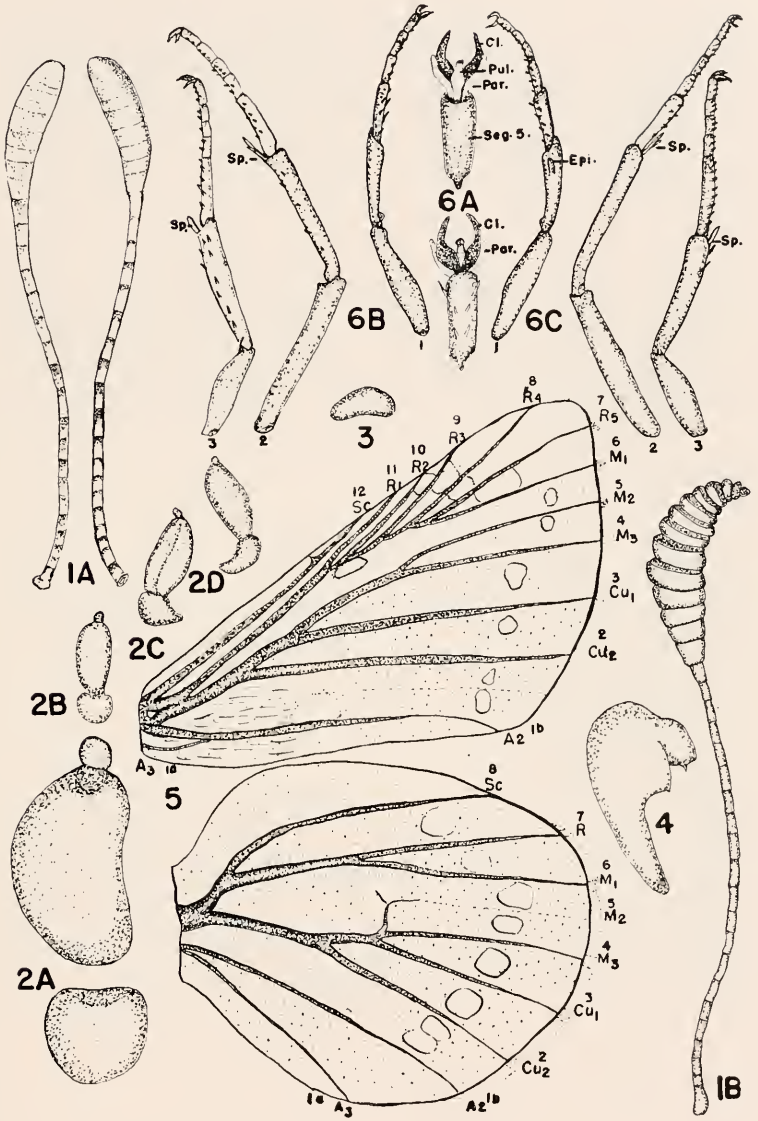

PLATE 19

For explanation of figures see page 258.

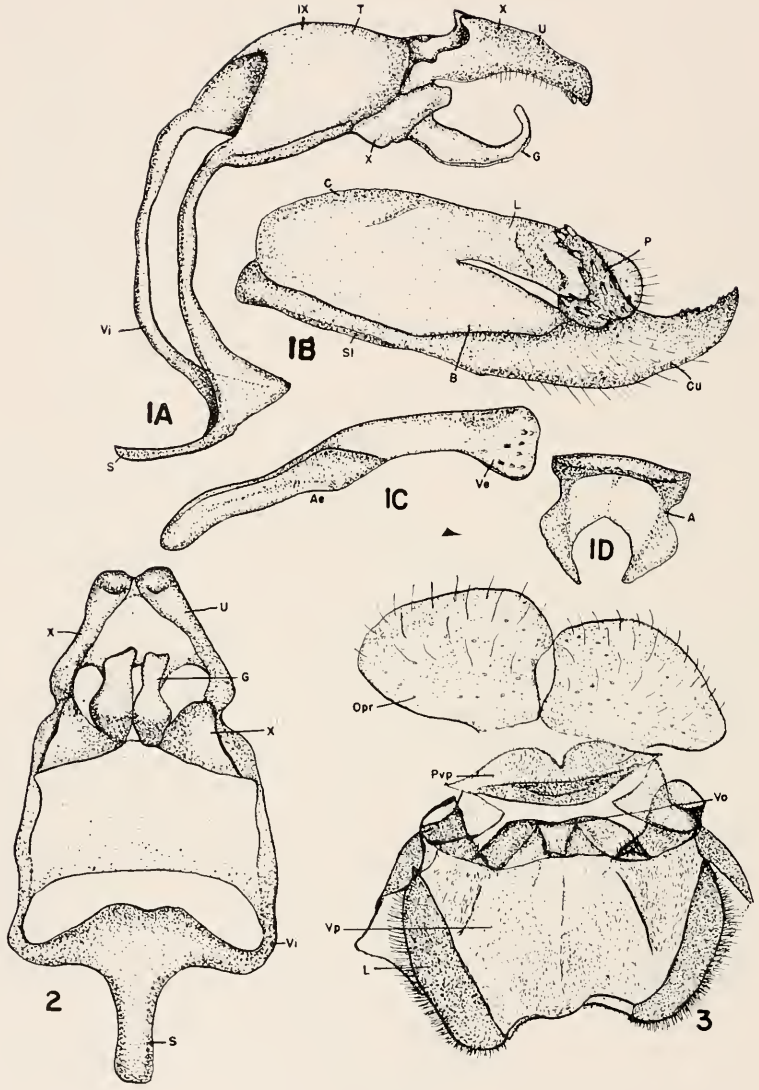

Plate 20

For explanation of figures see page 258.

Plate 21

Figures 1 to 8. Adults, upper and under surfaces.

1, 2. *Megathymus comstocki* Harbison, holotype male.

3, 4. *Megathymus comstocki* Harbison, paratype male.

5, 6. *Megathymus comstocki* Harbison, allotype female.

7, 8. *Megathymus comstocki* Harbison, paratype female.

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PLATE 22

NOTES ON THE METAMORPHOSIS OF AN AGAVE-BORING BUTTERFLY FROM BAJA CALIFORNIA, MEXICO

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SAN DIEGO, CALIFORNIA

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NOTES ON THE METAMORPHOSIS OF AN AGAVE-BORING BUTTERFLY FROM BAJA CALIFORNIA, MEXICO

BY
JOHN ADAMS COMSTOCK

INTRODUCTION

The recent publication by Charles F. Harbison (1957) of a new species of agave-boring skipper, *Megathymus comstocki,* has established the first authentic record of an indigenous species of this interesting genus from Baja California.

The writer had the pleasure of participating in a field study of the species with a group of naturalists, working in the area two miles northeast of San Simón, Baja California, under the aegis of the San Diego Society of Natural History, September 9 and 10, 1955.

A record of that trip, with a description of the physical and ecological features of the type locality of the new species, was adequately set forth in Harbison's paper.

My interest and effort centered largely around the factors concerned in the life history of this butterfly, and of other lepidoptera in the area. Having previously (1934) investigated and published on the metamorphosis of *Megathymus stephensi* Skinner, and more recently (1956) on *Megathymus evansi* Freeman, it was my hope that a similar investigation of the habits of the new species might bear fruit. Efforts along that line had previously been made by others, without results.

ACKNOWLEDGMENTS

I am greatly indebted to the several collaborators who had previously carried on studies in the Genus *Megathymus,* and who have generously given of their knowledge, experience, and published records. This particularly includes H. Avery Freeman of Garland, Texas; the late Brigadier W. H. Evans of the Department of Entomology, British Museum, London; Don B. Stallings of Caldwell, Kansas; and Lloyd M. Martin, Associate Curator of Entomology, Los Angeles County Museum.

Colonel Arthur F. Fischer, former Director of the San Diego Museum of Natural History, was most helpful in making available the facilities of that institution, and lending support and encouragement to the members of his staff engaged in research.

To Charles F. Harbison, Curator of Entomology, and indefatigable staff worker in the San Diego Museum of Natural History, I express appreciation for his dedication of the new species to one who is more grateful than worthy of the honor.

LARVAL HABITS OF *Megathymus comstocki*

Megathymus comstocki lives as a larva in the interior of the leaves of the century plant, known by the natives as "maguey", and to the botanist as *Agave*. The dominant agave in the San Simón area is one that was given the name *Agave orcuttiana* by Trelease, the type locality being San Quintín, Baja California. A number of authorities on the century plants are inclined to the opinion that *A. orcuttiana* is synonymous with *Agave shawii* Engelmann, or at best only a subspecies of the latter.

In this connection, Stallings and Turner (1956) report that in the Redington—Tucson area of Arizona *Megathymus polingi* Skinner infests *Agave schottii* Engelmann, which is "the smallest known species (of true Agave) in the U.S.A." A glance at Plate 18 of Harbison's paper shows *Agave shawii* (*orcuttiana*) to be a large, robust, and heavy species, occurring frequently in large dense clusters. This marked difference in food plants serves further to set apart *Megathymus comstocki* from its nearest relative, *M. polingi*.

Locating the larval chambers of *M. comstocki* in these plants proved, at first, to be more difficult than was anticipated, owing to the fact that they are at a lower and less exposed level than the larval chambers of *Megathymus stephensi* or *M. evansi*. The burrows of these species occur at a level well within the range of visibility, and the entrances are typically on the upper surfaces of the leaves. In consequence, the 'doorway' to the larval tunnel is usually visible, and, in addition, the extruded frass pushed out by the larva forms a telltale accumulation that is plainly discernible. The entrance to the burrow of *M. comstocki* is on the underside of the leaf, below the range of visibility.

It probably takes considerable time for the young larva of *M. comstocki* to channel its way down through the leaf to a location near its base, where it eventually cuts out the chamber in which it spends the greater part of its larval span, and in which it finally pupates. It was particularly noted that the channel and chamber were contained in a single leaf. This is in marked contrast to the habit described by Stallings and Turner (1956) for *Megathymus polingi*. That species extends its

burrow and chamber through more than one leaf, and into the main stalk or heart of the plant.

During its larval span *M. comstocki* extrudes its frass and exuviae, as do *M. stephensi* and *polingi,* and after each sanitary performance, the exit is sealed and the burrow is thus closed to unwelcome intruders. Even this precaution does not prevent the attacks of dipterous and hymenopterous parasites, many of which were found in the pupal chambers.

THE OVUM, AND OVIPOSITION

In the short time at our disposal, it was impossible to obtain information on the ovum, or on the method of ovipositing. It is however assumed that, as in certain other species, the female takes a position on the plant, and snaps or 'flicks' off her eggs, one at a time. These probably fall close enough to the plant so that the young larva can seek a leaf and burrow in near its tip. To demonstrate this assumption with certainty would require observation in the field over a considerable period of time. The method of ovipositing of the several yucca-feeding megathymids is entirely different. The writer, in association with the late Charles M. Dammers, (1934) established *Megathymus yuccae martini* Stallings & Turner, affixes its egg solidly to the tip of a young and succulent yucca leaf, and that the newly hatched larva burrows immediately into the leaf, and thence down into the root.

COLLECTING TERRAIN AND TECHNIQUE

As previously reported by Harbison in his careful and thorough description of the new species, the type locality is a small side canyon of Santa María Valley, about two miles northeast of San Simón, Baja California Norte. The surrounding hills are heavily clothed with subtropical desert vegetation, in which *Agave shawii* (*orcuttiana*) and numerous cacti dominate. This is a rough and difficult terrain in which to collect.

This agave is a compact unyielding plant, frequently growing in crowded clumps, closely appressed to its fellows, seldom erect and solitary. Its associates are predominantly spine-armored or thorny. Its own sharp, recurved teeth along the margins of each leaf necessitate the use of heavy gloves.

We were unable to locate the larval chambers until we had severed the plant close to the ground, turned it top end down, and peeled off the leaves, one by one, as a person does with an artichoke. The first leaves

to be thus removed were those that were dried and shriveled. In these we discovered old and previously evacuated larval chambers.

As this peeling process proceeded downward on the upturned plant, and the leaves began to show some green at their bases, the larval burrows evidenced more recent occupancy. A few contained live pupae, and several held shriveled larvae with puparia of a dipterous parasite.

Mature larvae were encountered in green leaves immediately proximal to the desiccated layer. From that point onward toward the tip of the plant, most of the leaves were sterile.

This process is long and tedious, and the total larvae plus pupae obtained in the two days was only ten. A considerable number of chambers containing empty pupal cases showed that we were somewhat late in the season.

This collecting procedure is apparently the only one that gives successful results with *M. comstocki*. Obviously it means destruction of each agave examined, but by selective cutting in large masses the remaining plants may be benefited.

The method employed in securing larvae of *M. stephensi* from *Agave deserti* Engelmann is in strong contrast to that described above. The technique consists in using a crowbar to pry out a few leaves adjacent to the one suspected of containing a larva or pupa, then removing the desired leaf by hand. Plants thus handled soon repair the slight damage.

As with all megathymids, netting the imagines of *M. comstocki* requires dexterity, and the results are seldom satisfactory. The insect is a rapid and erratic flyer and frequently beats itself into a ragged condition before it can be transferred to the cyanide jar.

In the rugged terrain that is its home, the thorny bushes cause casualties to the net, and one must always move with caution, to avoid dermal punctures with cactus spines or thorns. Rattlesnakes should also be kept in mind, although, in this particular locality, only one was observed during our stay.

Permits had previously been obtained by the authorities of the San Diego Museum of Natural History for passing the living material through the inspection station at the border on our return. The viable specimens were thereafter held in the laboratory under careful safeguards against escape.

From the eight mature larvae and two pupae, only three imagines emerged, one of which was deformed. The remaining larvae were

dormant for a considerable period of time before giving forth hymenopterous parasites.

Of the two females thus obtained in good condition, one served as the allotype (No. 1), and the other as paratype (No. 8) in Harbison's type series.

Notes were made of the larva and pupa, and drawings prepared, as will be noted on our figure (Plate 22).

LARVA OF *Megathymus comstocki*
(Plate 22, fig. 1)

MATURE LARVA: Length, 33mm. for the single example measured. The subcylindrical body tapers toward the head for the first three segments, and gradually narrows toward the cauda on the last six segments. It is characteristically grub-like in appearance.

HEAD: hemispherical, small, light tan in color, and covered with dull yellow hairs. The mouth parts are brown, and the ocelli concolorous with the head.

BODY: ground color bluish gray, the segmental junctures shading to gray, and the caudal segments tinged with brown.

A conspicuous dark brown scutellum on the first segment arches across the neck, uninterrupted in the median line.

There is a submedian longitudinal row of black points, one to a segment on each side. Each point bears a short black seta. A second row of similar character parallels this laterally, but is less conspicuous, and bears shorter setae.

There is a middorsal longitudinal pulsating green line.

The spiracles are rimmed narrowly with black. The true legs are concolorous with the body, except that their tips are tinged with light brown. The prolegs are likewise colored as is the body, and bear light gray crochets.

The body is thickly sprinkled with minute yellowish hairs, discernible only under a lens.

The body surfaces produce a flocculent white powder shortly before pupation, but not to the profuse degree that was observed in *Megathymus stephensi*.

Pupa of *Megathymus comstocki*
(Plate 22, figs. 2 - 3)

Measurements: Length, 28 mm. Greatest width through center, 7 mm.

The fusiform body tapers gradually toward the cauda and more abruptly toward the head.

Head: Rounded, with the central cephalic elements protruding forward in two lobes, one on each side of the median line.

The prominent eyes bulge laterally. Their color is slightly darker than the dark brown of the head.

The leg sheaths and antennae are light brown, and the wing cases yellow-tan. The maxillae extend to a point approximately 2 mm. cephalad of the wing margins, and the antennae are still shorter by about 1½ mm.

The abdominal segments are dark brown, tinged with olive, and the spiracles are concolorous with the body.

Other structural features are adequately shown in the illustration, Plate 22, figures 2 and 3.

Comparisons

It has been generally assumed that any *Megathymus* occurring below the California — Mexican border, with a range more or less contiguous to that of the San Diego County species, would likely prove to be a close relative of *Megathymus stephensi*. The following table of comparisons, together with the genitalic differences demonstrated by Harbison, prove that such is not the case.

Comparsions of the Larvae

M. comstocki	*M. stephensi*
Shorter (33 mm.)	Longer (40 mm.)
Slender	Robust
Tapering gradually towards cauda	Tapering abruptly towards cauda
Hair covering of head relatively long	Hair covering of head short
Ocelli concolorous with head	Ocelli dark brown
Body color bluish gray	Body color soiled ivory
Body pile yellowish	Body pile brownish
Crochets light gray	Crochets black

COMPARISONS OF THE PUPAE

M. comstocki	*M. stephensi*
Subfusiform	Subcylindrical
Curved ventrally	Straight
Tapering caudally on last seven segments	Tapering caudally only on last four segments
Head irregularly rounded	Head regularly rounded
Color of head dark brown	Color of head amber
Abdominal segments dark brown, tinged with olive	Abdominal segments greenish-yellow
Cremaster long, flat, recurved	Cremaster short, relatively straight

Harbison's thorough analysis of his new species, and his figures of genitalic armature, indicate that it is distinct from all others in the genus, its closest relative being *Megathymus polingi* Skinner, described originally (1905) from "Southern Arizona."

Stallings' and Turner's recording of *Agave schottii* as the food plant of *M. polingi* is significant, as it is well established that nearly every agave-feeder lives in a separate species of agave.

(Freeman had previously reported *M. polingi* as feeding in *Agave Palmeri* Engelmann (1951) but he recently (*in litt.*) corrected this to *A. schottii.*)

PARASITES

As previously stated, a number of puparia of dipterous parasites were found in the larval chambers, along with the shriveled larvae of *M. comstocki,* from which they had emerged. These were left with Paul Arnot (a member of our party on the San Simón trip). As yet, no report on these has been received.

In addition, several hymenopterous parasites emerged from the seven surviving larvae that were under observation in our laboratory. These were submitted to P. H. Timberlake, of the Citrus Experiment Station, University of California, at Riverside, who determined them as *Apanteles megathymi* Riley, with the comment that "This parasite was described from North Carolina, but it has been recorded from Arizona and California."

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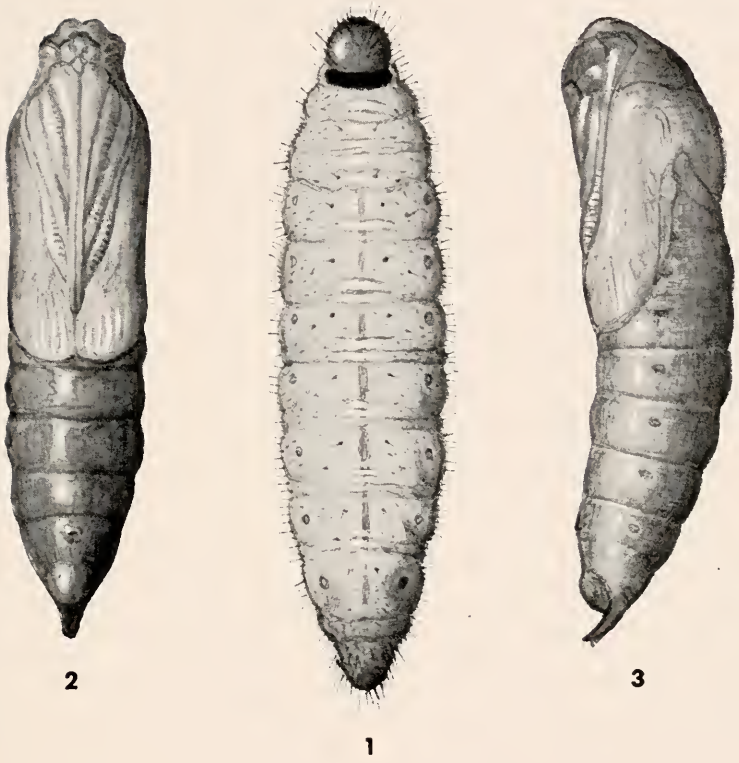

PLATE 22

Larva and pupa of *Megathymus comstocki* Harbison

1. Larva, dorsal aspect. 2. Pupa, ventral aspect. 3. Pupa, lateral aspect. All figures enlarged approximately X 3. Reproduced from a painting by the author.

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TRANSACTIONS

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FISH REMAINS FROM ABORIGINAL SITES IN THE PUNTA PENASCO REGION OF SONORA, MEXICO

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It has been my privilege to examine a collection of fish remains obtained by Professor E. W. Gifford, of the University of California, from two aboriginal sites in the Punta Peñasco region of northwestern Sonora, México. One of these sites is near Punta La Cholla, some five miles west and north of Punta Peñasco. The other site, El Esterito, is near the mouth of the Sonoita River, approximately ten miles south and east of Punta Peñasco. These aboriginal sites have been described by Gifford (1946, pp. 216-218, fig. 29), and have been compared by Schenck and Gifford (1952, p. 265) with similar sites at San Felipe, Baja California, on the opposite shore of the Gulf of California. Photographs and maps of Punta La Cholla and vicinity were published by Hertlein and Emerson (1956, figs. 1-2; pl. 12, figs. 1-3).

NOMENCLATURE

The ichthyological nomenclature employed in this paper generally follows that of Hubbs and Follett (MS.). The osteological nomenclature follows the later usage of Starks (1901, 1923, 1930).

FISHES REPRESENTED

The collection, taken from the sites and at the depths noted on page 282, consists of 41 fish remains. Of these, the 38 that are identifiable represent the nine species listed below. All are commonly taken, at one season or another, in comparatively shallow water near the head of the Gulf of California.

TRIAKIDIDAE — Smoothhounds

Mustelus lunulatus Jordan and Gilbert (?). — The sicklefin smoothhound is edible and is sold in the markets, according to Berdegué (1956, p. 105), who stated that the vernacular name "tiburón mamón" ("suckling shark"), applied to this species, refers to its weak dentition and small size. We saw one of these sharks captured on hook and line from a rocky promontory at Punta San Felipe. The 68½-inch specimen recorded by Norris (1923, p. 1) is the largest of which I have found mention. A figure of this species was published by Kumada and Hiyama (1937, pl. 47). MATERIAL (referred with some doubt to this species): seven complete *centra*, possibly all from the same fish, which was approximately 30 inches long. Because of the lack of adequate comparative material, the identification is presumptive.

CARCHARHINIDAE — Requiem Sharks

Scoliodon longurio (Jordan and Gilbert). — The Pacific sharpnose shark is used as food to a limited extent in Panamá, according to Meek and Hildebrand (1923, p. 53). The 42½-inch specimen, weighing nine pounds, recorded by Beebe and Tee-Van (1941, p. 112), is the largest I have found mentioned. Walford (1944, p. 5) stated that this species was known as "puro" ("cigar"; doubtless in reference to its shape). A figure of this shark was published by Hubbs and McHugh (1950, fig. 3). MATERIAL: one complete *centrum*, from a fish approximately 16 inches long.

SERRANIDAE — Basses

Mycteroperca jordani (Jenkins and Evermann). — The Gulf grouper, "baya," is a valuable food fish, according to Evermann and Jenkins (1891, p. 143). It was stated by Jordan and Evermann (1896, p. 1177) to be common in bays and sheltered waters of the Gulf, but not about rocks. Walford (1937, p. 105) reported the largest specimen caught by his party as measuring four feet eight inches in length, although elsewhere (1936, p. 8) he referred to a specimen that measured between five and six feet. Figures of both young and adult were published by Walford (1937, pl. 12, fig. a). MATERIAL: one nearly complete *vertebra*, the 1st precaudal, from a fish approximately 15 inches long. The identification is made on the basis of agreement with a 235-mm. specimen of *Mycteroperca jordani* from Guaymas, and of disagreement with material of *Epinephelus analogus* Gill and of *Paralabrax maculatofasciatus* (Girard).

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MUGILIDAE — Mullets

Mugil cephalus Linnaeus. — The striped mullet, "lisa" (Beltrán 1934, p. 7), is exceedingly abundant in the Gulf. At times during our stay at San Felipe, scarcely a second would elapse when a leaping mullet could not be seen in one direction or another. Berdegué (1956, p. 127), who commented on its extensive use for food, stated that the Yaqui fishermen take it with the spear. Since this species feeds on minute algae and detritus (Dill 1944, p. 141), it is seldom taken on hook and line. Furthermore, it is so agile that it will usually leap over a seine, although according to Thompson and Bryant (1920, p. 60) it has been captured by weirs placed in shallow water. Roedel (1953, fig. 76) published a photograph of this species. MATERIAL: one incomplete *basioccipital;* one nearly complete left *hyomandibular* (fig. 1); nine incomplete caudal *vertebrae*, appearing to represent the 3rd, 4th, 6th, 8th, 10th, 11th (two), 12th, and 13th; one complete *hypural*. These elements are from fish ranging approximately from 15 to 20 inches in length.

SPARIDAE — Porgies

Calamus taurinus (Jenyns) (?). — The Pacific porgy, "mojarrón chino" or "mojarra garabata," is an important food fish, according to Berdegué (1956, p. 251), who stated that it attains a length of approximately 18 inches. A colored plate of this species was published by Kumada and Hiyama (1937, pl. 33) and another, by Walford (1937, pl. 68). MATERIAL: one incomplete *vertebra*, questionably the 1st caudal, from a fish approximately 15 inches long. The identification is queried because of minor inconsistencies observed on comparing material.

SCIAENIDAE — Croakers

Cynoscion xanthulus Jordan and Gilbert. — The orangemouth corvina was one of the best food fishes that we encountered at San Felipe. We took it occasionally on hook and line while fishing from a sand beach, although we caught it more frequently from a skiff a short distance offshore. Jordan and Evermann (1898, p. 1410) stated that it attains a length of three feet. A photograph of this species was published by Walford (1937, pl. 20, fig. d). MATERIAL: one incomplete *vertebra* (fig. 2), the 7th (?) caudal, from a fish more than 30 inches long.

Cynoscion macdonaldi Gilbert. — The totuava, also spelled "totoaba" (Beltrán 1934, p 12; Berdegué 1956, p. 235), attains a weight of at least 225 pounds (Walford 1937, p. 132). It was reported by Gilbert (1890, p. 65) as being very abundant along the entire eastern shore of the Gulf and as feeding in shallow water, where it was easily approached and speared. Nakashima (1916, pp. 85, 86) stated that this species often comes into very shallow water; that it is not very shy; and that when one is hooked or speared, the others crowd around as if in curiosity. The wasteful exploitation of this food fish since the advent of the white man has been described by Chute (1928, p. 275). A photograph of the spotted juvenile stage was published by Berdegué

(1956, fig. 168), and an excellent color photograph of the adult, by Walford (1937, pl. 65). MATERIAL: one fragmentary left and one fragmentary right *epiotic;* one incomplete left *quadrate* (fig. 3); one fragmentary right *maxillary;* one fragmentary right *ceratohyal;* four *vertebrae* (two nearly complete, the 3rd and 4th precaudal, probably from the same fish; one fragment, the 6th precaudal; one fragment, the 6th (?) caudal); two fragmentary *fin rays* (dorsal and caudal); one fragment, questionably *epural.* These elements are from fish ranging approximately from 20 to 60 inches in length.

GIRELLIDAE — Nibblers

Girella simplicidens (Steindachner). — The Gulf opaleye occurs about rocky points, its young entering tide pools, as at Punta San Felipe, where we found it abundant. It is edible, though not esteemed. Osburn and Nichols (1916, p. 166) recorded a specimen 15 inches in length and published a figure of this species. MATERIAL: one incomplete *vertebra,* the 1st (?) caudal, from a fish approximately 9 inches long.

BALISTIDAE — Triggerfishes

Verrunculus polylepis (Steindachner). — That the fine-scale triggerfish is used as food was indicated at San Felipe, where on two occasions the remains of adults, with the flesh sliced from each side, floated past our camp. We caught a number of small specimens by hook-and-line fishing from rocky points. This species was stated by Jordan and Evermann (1898, p. 1700) to reach a length of two feet. It is known as "pez puerco," according to Beltrán (1934, p. 10). Photographs of this fish and of its trigger mechanism were published by Clothier (1939, figs. 86-89). MATERIAL: two incomplete *vertebrae,* the 1st precaudal (fig. 4), from a fish approximately 14 inches long, and the 4th precaudal, from one of approximately 10 inches.

FISH REMAINS, BY SITE AND DEPTH

The numeral heading each paragraph is a catalog number of the Museum of Anthropology, University of California, Berkeley.

3-15177. La Cholla Bay, approximately one-fourth mile north of "Site 1" as indicated by Gifford (1946, fig. 29), on face of sand dunes near the slough; depth 13 to 26 inches. — *Mugil cephalus*: left hyomandibular (fig. 1). *Cynoscion macdonaldi*: two epiotic fragments (left and right); left quadrate (fig. 3); right-maxillary fragment; right-ceratohyal fragment; 6th (?) caudal vertebra, fragmentary. Unidentified material: two fragments.

3-15178. Same site and depth as preceding. — *Cynoscion xanthulus*: 7th (?) caudal vertebra (fig. 2).

3-15179. Same site and depth as preceding. — *Mugil cephalus*: basioccipital; five vertebrae, appearing to represent the 6th, 8th, 11th, 12th, and 13th caudal. *Calamus taurinus* (?): 1st (?) caudal vertebra. *Cynoscion macdonaldi*: two vertebrae, the 3rd and 4th precaudal. *Verrunculus polylepis*: 4th precaudal vertebra.

3-15184. La Cholla Bay, approximately one-fourth mile north of "Site 1" as indicated by Gifford (1946, fig. 29), on hummock No. 4 near the slough; depth 20 to 30 inches. — *Scoliodon longurio*: centrum. *Mugil cephalus*: three vertebrae, appearing to represent the 4th, 10th, and 11th caudal; hypural. *Cynoscion macdonaldi* (?): 6th precaudal vertebra, fragmentary. *Girella simplicidens*: 1st (?) caudal vertebra. *Verrunculus polylepis*: 1st precaudal vertebra (fig. 4). Unidentified fragment: rim of vertebra.

3-15231. El Esterito, at "Site 3" as indicated by Gifford (1946, fig. 29); depth 0 to 6 inches. — *Mustelus lunulatus* (?): seven centra. *Mugil cephalus*: 3rd (?) caudal vertebra.

3-15246. Same site as preceding; depth 6 to 12 inches. — *Cynoscion macdonaldi*: dorsal-ray fragment; epural (?) fragment; caudal-ray fragment.

3-15281. Same site as preceding; depth 18 to 24 inches. — *Mycteroperca jordani*: 1st precaudal vertebra.

ACKNOWLEDGMENTS

For the opportunity to report on this collection of fish remains, I wish to acknowledge my indebtedness to E. W. Gifford. I wish also to express my appreciation to my wife, Evelyn Follett, and especially to Richard S. Croker and his wife, Annie Croker, for extensive assistance, during a week's stay at San Felipe, in collecting most of the comparative material used in identifying these remains. My thanks are due to Lillian Dempster and to Carl L. Hubbs for aid in the preparation of the manuscript.

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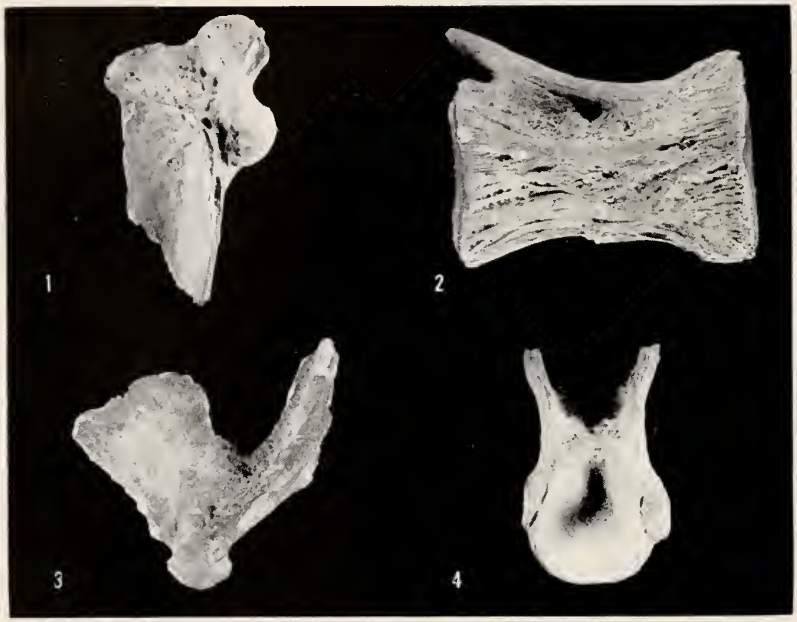

Fig. 1. *Mugil cephalus*, left hyomandibular; height 25 mm.; UCMA 3-15177. Fig. 2. *Cynoscion xanthulus*, 7th (?) caudal vertebra; length 30 mm.; UCMA 3-15178. Fig. 3. *Cynoscion macdonaldi*, left quadrate; height 26 mm.; UCMA 3-15177. Fig. 4. *Verrunculus polylepis*, 1st precaudal vertebra; height 14 mm.; UCMA 3-15184.

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TRANSACTIONS

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A NEW RACE OF WOOD RAT (NEOTOMA) FROM THE GULF SIDE OF CENTRAL BAJA CALIFORNIA, MEXICO

BY

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Study of the chain of races of *Neotoma lepida*, from southern California down through the peninsula of Baja California, reveals the presence of an undescribed race on the coastal Gulf slope of the central section of this long peninsula. This race may be known as

Neotoma lepida aridicola subsp. nov.
SAN FRANCISQUITO WHITE-FOOTED WOOD RAT.

TYPE.—From El Barril (near 28° 20′ N), Gulf of California, Baja California, Mexico; No. 15595, collection of the San Diego Society of Natural History; adult male; collected by Laurence M. Huey, March 27, 1947.

CHARACTERS.—*Neotoma lepida aridicola* is similar in body size to *Neotoma lepida felipensis*, the race living along the Gulf coast to the north in the vicinity of San Felipe, but its buffy color appears richer and brighter when the two forms are compared in series. Cranially, *N. l. aridicola* differs from *N. l. felipensis* in several characters. The rostrum is narrower and more slender and the braincase is more rounded when viewed dorsally. Posteriorly, the braincase is narrower and more vaulted. The ventral surface of the skull of *N. l. aridicola* shows several outstanding differences when compared with *N. l. felipensis*. The molars are smaller and the series from m^1 to m^3 tapers more acutely. The pterygoids are more nearly parallel than those of *N. l. felipensis*, and the auditory bullae are decidedly smaller and rounder.

Compared with *Neotoma lepida molagrandis*, the race that occupies the opposite side of the peninsula on the Pacific Ocean slope, *N. l. aridicola* is immediately set apart by its very light-colored pelage and its smaller size. In cranial characters *N. l. aridicola* differs as much from *N. l. molagrandis* as it does from *N. l. felipensis;* the bullae are smaller and more rounded, and the molariform teeth are smaller.

The light-colored desert race *N. l. aridicola* differs conspicuously in color from the dark-pelaged *Neotoma lepida ravida*, the race found in the black lava mountainous district to the south. Cranial differences are not so pronounced as between the two former races, though the molariform teeth and auditory bullae differ slightly.

MEASUREMENTS OF TYPE.—Total length, 325; tail, 145; hindfoot, 31; ear, 28. *Skull*: Greatest length, 41.2; zygomatic breadth, 21.1; interorbital breadth, 5.3; greatest length of nasals, 16.2; length of palatal bridge, 7.4; alveolar length of upper molar series, 7.3.

RANGE.—So far as known, the desert slopes on the Gulf side of the peninsula in the region from San Francisquito Bay to El Barril. Further exploration of the arid Gulf slopes will probably show that this race lives considerably farther both to the north and to the south.

REMARKS.—Studies of the various species of small land mammals living on the peninsula of Baja California reveal links in the racial chains yet to be described. These are to be found in the remote regions which are difficult of access in this interesting land. As these areas are explored and carefully trapped, novelties will be collected, such as the wood rat described herein.

Following is a list, with type localities, of the races of the wood rats of the *Neotoma lepida* group now known to occur on the peninsula, exclusive of its islands.

Race	Type locality
Neotoma lepida intermedia	Dulzura, San Diego Co., California.
Neotoma lepida gilva	Banning, Riverside Co., California.
Neotoma lepida felipensis	San Felipe, Baja California, Mexico.
Neotoma lepida egressa	1 mi. e. of El Rosario, Baja California, Mexico.
Neotoma lepida molagrandis	Santo Domingo Landing (3 mi. inland from beach; near 28° 15′ N), Baja California, Mexico.
Neotoma lepida aridicola	El Barril (near 28° 20′ N), Gulf of California, Baja California, Mexico.
Neotoma lepida ravida	Comondú, Baja California, Mexico, alt. 700′
Neotoma lepida pretiosa	Matancita (= Soledad), 50 mi. n. of Magdalena Bay, Baja California, Mexico.
Neotoma lepida notia	La Laguna, Sierra de la Victoria, southern Baja California, Mexico.
Neotoma lepida arenacea	San José del Cabo, Baja California, Mexico.

SPECIMENS EXAMINED.—*Neotoma lepida felipensis*. Baja California, Mexico: San Felipe (type locality), 15.

Neotoma lepida egressa. Baja California, Mexico: 7 mi. e. of San Quintín, 3; 10 mi. e. of San Quintín, 5; Santa Maria near San Quintín, 7; San Quintín, 4; Aguaita, 1; 15 mi. nw. of San Fernando, 5; Santa Catarina Landing, 1.

Neotoma lepida ravida. Baja California, Mexico: south end of Conception Bay, 7; Comondú (type locality), 5.

Neotoma lepida aridicola. Baja California, Mexico: El Barril (near 28° 20′ N), Gulf of California (type locality), 11; 7 mi. w. of San Francisquito Bay, 2

Neotoma lepida molagrandis. Baja California, Mexico: Santo Domingo Landing (3 mi. inland from beach; near 28° 15′ N; type locality), 2; Punta Prieta, 2; Mesquital, 2; Calmallí, 1; Santa Gertrudis, 1; 12 mi. e. of El Arco, 1; San Ignacio, 3.

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TRANSACTIONS

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VOLUME XII, No. 16, pp. 289-308, figs. 1-6

LATE PLEISTOCENE FAUNAS FROM THE NORTHWESTERN COAST OF BAJA CALIFORNIA, MEXICO

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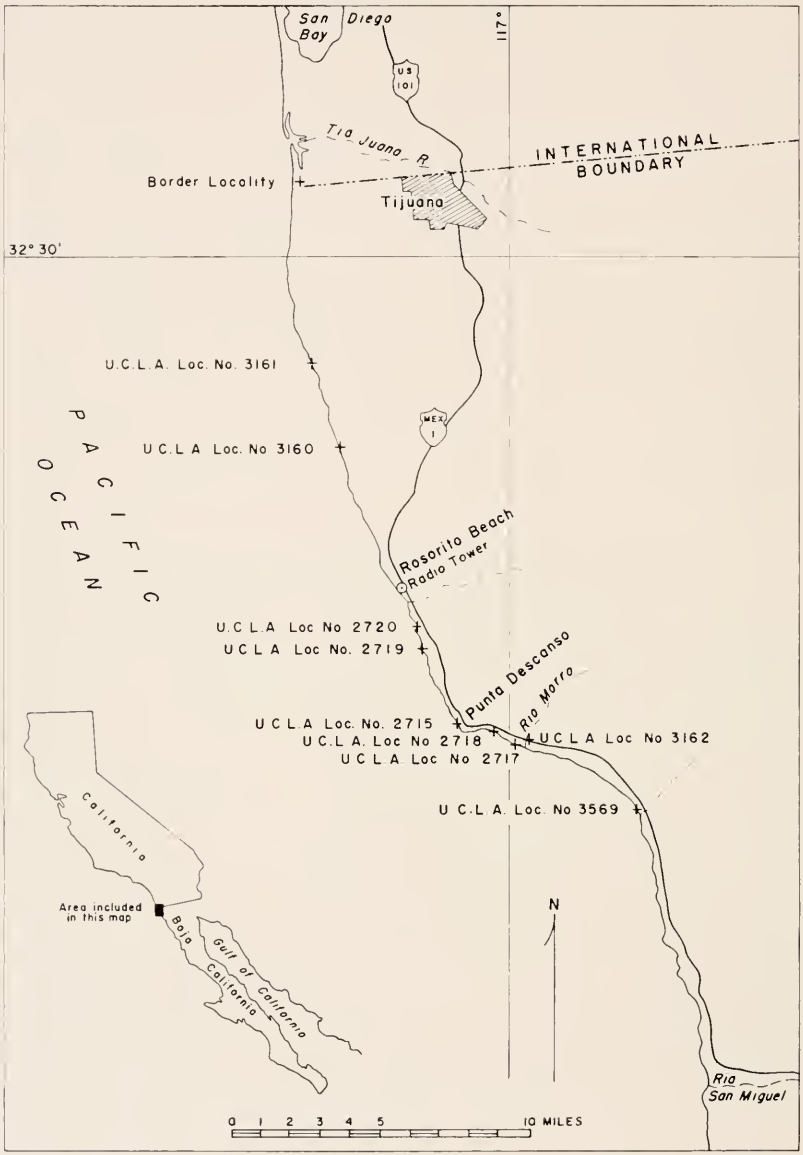

FIG. 1. Index map of northwestern Baja California, showing fossil localities between the International Boundary and Río San Miguel recorded here.

Base maps: U. S. Navy Hydrographic Office Chart no. 1149, San Diego to Bahia San Quintin, ed. 45, 1948; U. S. Army Air Force Preliminary Base Map, (404C) San Diego, 1945.

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LATE PLEISTOCENE FAUNAS FROM THE NORTHWESTERN COAST OF BAJA CALIFORNIA, MEXICO

BY

JAMES W. VALENTINE

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INTRODUCTION

The Council of the Eighteenth International Geological Congress (Anonymous 1950) recommended that the base of the Pleistocene in its type-area in Italy be drawn at the base of the Calabrian (marine) and Villefranchian (continental) formations. It was noted in the recommendation that this boundary coincides with the earliest indication of climatic deterioration in the late Cenozoic section of Italy. In order to locate this boundary in marine sediments of other regions, it seems necessary to determine the major features of Pleistocene oceanic circulation patterns in each area and their thermal significance. In view of the great provinciality of Pleistocene faunas, such a climatic approach to Pleistocene correlation, particularly on the interprovincial and intercontinental scales, is promising. Reconstruction of the history of marine Pleistocene circulation in the eastern Pacific should greatly aid the establishment of stage boundaries here.

In the hope of bringing more evidence to bear upon this problem, a study of Pleistocene invertebrate faunas has been undertaken, particularly those from marine terraces along the coast of southern California and Baja California. These terrace faunas provide especially favorable material for paleoecologic studies, inasmuch as representatives of nearly all the species are living today in the eastern Pacific. Thus reconstructions of their ancient environments may

be based directly upon their present distribution and habits. Furthermore, the paleogeographic settings of many terrace fossil localities are suggested by present topography. The configuration of a terrace shoreline is commonly indicated by the position of ancient sea-cut cliffs at the landward margins of the terrace. The difference in altitude between a fossil locality and this shoreline approximates the maximum depth of water under which the fauna could have been deposited.

A large number of invertebrate assemblages, chiefly of mollusks, has been described from Upper Pleistocene marine terraces in southern California. The majority of species in these faunas live today in shallow-water environments such as were doubtless present near the fossil localities. To interpret the environment of such assemblages of Recent types in known geographic situations is to approach paleoecology in its simplest aspect. Nevertheless, the faunas regularly contain a few species that do not live at present in association or near-association with the bulk of the fauna. Except for cases of probable reworking, nearly all the ecologically anomalous forms represent either (1) locally extinct species that live in southern, warmer water or northern, cooler water or (2) locally deep-water types that live in shallow water only to the north. Cool-water types and warm-water types are found together at some localities. This situation has been well outlined by Woodring (in Woodring, Bramlette, and Kew 1946).

The present report, which is part of a larger work in progress, records faunas collected in 1952 from ten localities on the lowest remaining terrace between the International Boundary and Río San Miguel (fig. 1). The composition of these faunas was outlined in a preliminary paper (Valentine 1954).

Previous Work

Dall apparently was responsible for the earliest record of Pleistocene fossils from Baja California (1890, p. 145). A single species, *Eupleura muriciformis*, was reported from the "Pacific coast of Lower California."

Although no Pleistocene faunas have previously been described from the area under consideration, Emerson and Addicott (1953) enumerated a terrace fauna from just north of the International Boundary at the "Border locality" (fig. 1). The Border fauna, collected evidently from the same terrace as the fossils recorded here, was interpreted as indicating quiet shallow water with temperatures much like those of today.

A fauna recently described from terrace deposits at Punta China (Emerson 1956) represents the nearest recorded Pleistocene fossils to the south of Río San Miguel. The Punta China assemblage includes several species living only well to the north at present and was interpreted as indicating cooler water, at least locally, than is found near Punta China today. Records by Dall (1900, p. 1001; 1903, pp. 1245, 1258) of Pleistocene shells from Todos Santos Bay presumably are based upon Indian midden material.

DESCRIPTION OF THE AREA

General Features

The coast between the International Boundary and Río San Miguel (fig. 1) is chiefly one of steep irregular or crescentic beaches, separated by rocky points and backed by sea-cut cliffs. In the Punta Descanso region and northward, rocks exposed in the cliffs are black to dark reddish vesicular basalts interbedded with light colored tuffs and tuffaceous sandstones. No fossils are reported from these rocks. Hertlein and Grant (1944, p. 60) suggested that these volcanics overlie the San Diego formation, and are therefore of "late San Diego age" (Upper? Pliocene). They were mapped by Beale (1948, p. 74, pl. 1) as the "Comondú formation," a term he used to include "all volcanic rocks and terrestrial sediments of Tertiary age" in Baja California, and were assigned to the Middle or Upper Miocene on a reconnaissance map published by Anderson (1950, pl. 1).

From the Punta Descanso area southward to Río San Miguel, rocks exposed in the sea cliffs have been mapped as Cretaceous (Beale 1948, pl. 1, "Rosario formation"; Anderson 1950, pl. 1). The basis for the age assignment is not known; some of the rocks are massive tuffs and sandstones with interbedded basalts, and are not unlike the "Comondú" rocks farther north.

A terrace platform, eroded on "Comondú" and "Rosario" rocks, is exposed in the sea cliffs at altitudes chiefly between 25 and 45 feet. The platform surface slopes gently seaward, and differences in the altitude of the terrace platform at the sea cliffs are due largely to variations in the distance between the cliffs and the shoreline angle at the rear of the terrace. Wherever the position of the shoreline angle could be determined, it was judged to be at about 75 feet in altitude. Although the terrace is interrupted by several stream valleys, terrace segments north and south of the valleys extend for many miles at essentially the same altitudes and are presumably correlative. If so, this terrace extends from the San Diego region (as the Nestor terrace of Ellis, in Ellis and Lee 1919, pl. 6) at least as far south as Río San Miguel, a distance of approximately 45 miles. The configuration of the terrace shoreline suggests that the coast was formerly one of alternating rocky shores and sandy beaches, much as it is today. The ten fossil assemblages recorded below were collected from marine deposits preserved locally on this terrace platform.

Local Features

A notable exposure of Pleistocene sediments occurs on the north side of Punta Descanso (figs. 2, 3), where about 3 feet of richly fossiliferous pebbly sand, containing lenses of basalt cobbles at the base, lies on a basalt terrace platform (locality 2715). Overlying the sand is a second fossiliferous deposit, 3 feet thick, with a matrix of alluvium and comminuted shell (locality 2716). The upper unit evidently represents either (1) a non-marine deposit containing abundant reworked shell material eroded from a shoreward part of the underlying marine stratum or (2) a beach deposit with which alluvial material has mingled. The fossiliferous deposits are overlapped by an alluvial fan.

At Río Morro (locality 3162) the lowest terrace platform is clearly shown in a road cut (figs. 4, 5). This locality is near the rear of the terrace; remnants of the next higher terrace may be seen above the cut in fig. 4. Between 2 and 3 feet of a fossiliferous, poorly sorted sand, grit, and rubble conglomerate rest on the platform surface. Conglomeratic fragments of pebble to boulder sizes are well- to sub-rounded. The conglomerate is overlain by 4 to 5 feet of alluvium. The platform rocks are basalts, and the matrix of the fossiliferous stratum consists in large measure of weathered basaltic material. This deposit is interpreted as talus rubble washed or wasted from the former sea cliff, together with alluvium and talus material from higher terraces, intermingled with marine sediments.

Small lenses of fossil mollusks occur on the low terrace between the fossil localities reported here. These faunas are small, the shells usually well worn and broken; all species identified are found also in the assemblages listed below. The fauna of one of these fossiliferous lenses has been included in the list of species; the locality (locality 3569, 4½ miles south of Río Morro) is illustrated in fig. 6. It typifies the occurrence of small fossiliferous lenses. Between Río Morro and Río San Miguel, parts of the terrace are dissected into badlands by numerous steep-sided gullies, and marine sediments that locally contain a few shells are exposed in several of the deeper gullies near the present sea cliff.

Shells of mollusks used for food by the early Indians of Baja California are found throughout the area, usually within and upon alluvial fans mantling the marine terraces. The shells may be scattered and rare or in heaps or layers commonly termed Indian middens. At many localities, middens are so thick and extensive that they may readily be mapped. Only a few molluscan species are present in most of these middens, chiefly *Mytilus californianus, Septifer bifurcatus, Lottia gigantea, Haliotis cracherodi,* and *Fissurella volcano.* In collecting Pleistocene fossils in this region, it is necessary to exercise great care to insure against contamination by the closely associated midden shells.

COMPOSITION OF THE FAUNAS

General Features

A total of 230 molluscan species and subspecies are found in the collections, of which 23 are of more or less uncertain identity. Gastropods number 163, pelecypods 54, chitons 12, and scaphopods 1. The numbers of molluscan species found at each locality are tallied by classes in table 1. The greater number of gastropods relative to other classes at localities 2715, 2716, 2718, 2717, and 3162 is due to the presence of many small to minute species in these faunas. Six species are particularly abundant and widespread; these are *Mytilus californianus, Protothaca staminea, Olivella biplicata, "Nassa" fossata, Littorina scutulata,* and *Tegula funebralis.*

Remains of invertebrates of groups other than mollusks have not been identified, except for test fragments of the sea-urchin *Strongylocentrotus purpuratus* from localities 2715 and 2716. Barnacles (*Balanus* and *Tetraclita*),

TABLE 1. Composition of the faunas by classes, and present ranges of their species and subspecies

	U.C.L.A. LOCALITY NUMBER									
	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Identified species and subspecies	47	60	32	39	107	96	107	110	68	16
Species or subspecies of uncertain identity	1	1	1	6	7	4	7	10	4	4
Pelecypoda	14	18	12	17	24	22	20	28	13	7
Scaphopoda	1	1	0	0	0	0	1	1	0	0
Gastropoda	33	42	21	26	84	71	90	87	59	12
Amphineura	0	0	0	2	6	5	3	4	0	1
Species or subspecies living only to the north	1	5	2	4	5	6	7	7	3	1
Species or subspecies living only to the south	1	1	1	1	3	2	1	1	1	0

crab-claws, and worm-tubes are common at most localities. No foraminifera were found.

The following forms have not previously been recorded as fossil: *Lasaea subviridus, Odostomia trachis, O. virginalis, Cerithiopsis carpenteri, Triphora hemphilli, Nodulus kelseyi, Amphithalamus tenuis, Rissoina cleo, Caecum licalum,* and *Acmaea persona strigatella.*

Only a single form that is not known to be living, *Pseudomelatoma penicillata semiinflata,* is found in the collections.

SPECIFIC COMPOSITION OF FAUNAS

Table 2 lists by localities all species of mollusks collected. Each symbol in table 2 indicates the abundance of a species relative to the entire fauna collected at the locality. This method permits specific comparison between faunas irrespective of size. The following symbols are used:

Symbol	Meaning	Representation per 1000 specimens collected
V	Very rare	2 or fewer
R	Rare	3 to 8
C	Common	9 to 32
A	Abundant	33 to 128
S	Superabundant	129 or more

To obtain as many species as possible, somewhat selective collections were made at all localities. In addition, at richly fossiliferous localities, bulk collections were made to provide abundance data. Nevertheless, the abundance values in the table are biased in favor of scarce forms.

TABLE 2. List of species, showing abundance in each fauna

Meaning of symbols: V, very rare; R, rare; C, common; A, abundant; S, super-abundant. For further explanation, see page 295.

	U.C.L.A. LOCALITY NUMBER								
	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
PELECYPODA										
Nuculana taphria (Dall)	..	V	..	..	..	..	..	..	..	..
Glycymeris aff. *G. profunda* (Dall)	..	C	..	R	..	..	R	..	..	..
Glycymeris subobsoleta (Carpenter)	R	R	..	C	..	..	..	..	..	..
Barbatia bailyi (Bartsch)	..	..	..	..	R	V	..	..	..	..
Ostrea lurida Carpenter	..	V	..	..	..	..	..	V	..	..
Ostrea megodon Hanley	..	..	..	R	..	..	..	..	..	..
Leptopecten latiauratus (Conrad)	..	V	..	..	..	..	..	V	R	..
Leptopecten latiauratus monotimeris (Conrad)	R	..	..	..	R	..	..	..	..	..
Leptopecten ? sp	..	..	..	..	..	..	..	..	..	C
Pecten diegensis Dall	..	..	R	..	..	..	..	..	..	..
Hinnites giganteus (Gray)	C	..	..	..	..	V	V	V	V	..
Pododesmus macroschisma (Deshayes)	C	..	..	R	..	V	R	V	..	..
Mytilus californianus Conrad	A	C	A	A	R	C	V	V	R	C
Septifer bifurcatus (Conrad)	R	..	..	R	R	C	V	R	R	..
Modiolus fornicatus Carpenter	..	..	..	..	V	C	..	R	..	..
Glans subquadrata (Carpenter)	..	V	..	..	R	C	V	C	R	..
Milneria kelseyi Dall	..	..	..	..	C	..	..	V	V	..
Chama pellucida Broderip	..	..	..	..	V	V	R	V	..	..
Pseudochama exogyra (Conrad)	..	..	..	..	R	R	R	C	R	..
Epilucina californica (Conrad)	..	..	..	..	A	R	R	C	..	..
Here excavata (Carpenter)	..	..	..	R	..	..	..	..	..	..
Lucinisca nuttalli (Conrad)	R	R	R	R	..	..	R	V	..	..
Diplodonta orbella (Gould)	..	..	..	..	R	V	..	C	..	..
Kellia laperousi (Deshayes)	..	..	..	..	V	V	V	V	..	..
Lasaea cistula Keen	..	..	..	..	C	..	..	..	R	..
Lasaea subviridus Dall	..	..	..	..	C	V	..	R	R	..
Trachycardium cf. *T. quadragenarium* (Conrad)	..	..	..	R	..	..	..	..	..	..
Chione undatella simillima (Sowerby)	..	V	..	R	..	..	V	..	..	..
"Chione" picta Dall	..	..	..	..	V	V	..	..	..	..
Protothaca staminea (Conrad)	A	C	R	A	R	C	C	C	R	A
Irus lamellifer (Conrad)	..	..	..	..	..	V	V	..	..	..
Transenella tantilla (Gould)	..	..	..	..	C	V	V	C	..	..
Tivela stultorum (Mawe)	..	R	C	C	..	..	..	C	..	C
Saxidomus nuttalli Conrad	..	..	..	..	V	..	..	..	..	..
Amiantis callosa (Conrad)	R	..	..	..	V	..	..	..	..	..
Petricola californiensis Pilsbry and Lowe	..	..	..	..	..	..	..	..	..	C
Petricola carditoides (Conrad)	C	C	R	C	..	..	V	V	V	..
Tellina bodegensis Hinds	R	V	A	..	..	..	..	..	..	..
Macoma nasuta (Conrad)	R	V	..	..	..	..	..	..	..	..

TABLE 2.—Continued

	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Macoma secta (Conrad)	..	..	..	..	R	..	..	..	..	..
Semele rupicola Dall	..	..	..	..	..	V	..	..	..	..
Cumingia californica Conrad	..	..	..	..	C	V	..	V	..	..
Donax gouldi Dall	..	R	..	C	..	..	..	..	..	..
Sanguinolaria nuttalli Conrad	..	..	..	..	..	..	..	V	..	..
Siliqua lucida (Conrad)	..	..	R	..	..	..	..	..	..	..
Siliqua patula (Dixon)	..	..	..	V	..	..	..	..	..	..
Spisula "dolabriformis Conrad"	..	..	..	..	..	..	..	V	..	..
Spisula hemphilli Dall	..	..	..	..	..	..	..	V	..	..
Schizothaerus nuttalli (Conrad)	A	R	A	A	..	..	V	R	V	C
Cryptomya californica (Conrad)	..	V	R	..	R	V	V	V	..	..
"Corbula" luteola Carpenter	..	..	..	..	R	V	..	V	V	..
Hiatella arctica (Linnaeus)	..	..	..	..	R	V	V	..	..	..
Zirfaea pilsbryi Lowe	..	..	R	..	..	..	..	..	..	..
Pholadidea penita (Conrad)	A	C	R	R?	..	..	V	R	..	C?
SCAPHOPODA										
Dentalium neohexagonum Pilsbry and Sharp	C	C	..	..	..	..	C	C	..	..
GASTROPODA										
Acteocina culcitella (Gould)	..	..	..	..	V	..	V	R	..	..
Trimusculus reticulata (Sowerby)	C	V	C	A	V	C	V	..	C	C
Terebra pedroana Dall	..	C	R	..	..	..	R	R	..	..
Conus californicus Hinds	C	C	C	..	C	A	S	A	C	..
Megasurcula carpenteriana (Gabb)	C	..	C	R	..	..	..	..	..	..
Megasurcula carpenteriana tryoniana (Gabb)	R	R	..	..	..	..	..	..	..	..
Pseudomelatoma penicillata semiinflata Grant and Gale	..	..	..	..	..	..	R	..	..	..
Ophiodermella incisa fancherae (Dall)	..	R	..	..	..	..	C	V?	..	..
Ophiodermella ophioderma (Dall)	..	R	..	..	..	..	R	V?	..	..
Clavus cf. *C. empyrosia* (Dall)	..	..	..	..	..	..	V	..	..	..
Clavus hemphilli (Stearns)	..	..	..	..	..	..	R	V?	..	..
"Mangelia" interlirata Stearns	..	..	..	..	..	..	V	..	..	..
"Mangelia" variegata Carpenter	..	..	..	..	..	..	V	R	..	..
Mitromorpha aspera (Carpenter)	..	..	..	..	V	V	..	..	..	..
Mitromorpha filosa (Carpenter)	..	..	..	..	V	..	..	V	..	..
Cancellaria cooperi Gabb	..	V	..	..	..	..	..	..	..	..
Olivella baetica Carpenter	..	..	..	..	..	..	R	..	..	..
Olivella biplicata (Sowerby)	A	A	S	A	R	C	S	A	C	S
Olivella pedroana (Conrad)	A	S	..	..	..	..	..	..	..	..
Hyalina californica (Tomlin)	..	..	..	..	C	V	..	..	V	..
Cystiscus jewetti (Carpenter)	..	..	..	..	R	V	..	..	..	..
Cystiscus regularis (Carpenter)	..	..	..	..	V	..	V	..	..	..
Cystiscus subtrigona (Carpenter)	..	..	..	..	..	V	V	..	..	..
Cypraeolina pyriformis (Carpenter)	..	..	..	..	R	V	V	V	V	..
Mitra catalinae (Dall)	..	V	..	..	..	R	R	V	V	..

TABLE 2.—Continued

	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Mitra idae Melvill	..	V	..	..	..	V	R	..	..	..
"Fusinus" luteopictus Dall	..	..	..	..	..	V	..	..	..	..
Harfordia cf. *H. monksae* (Dall)	..	R	..	..	C	..	..	..	..	..
Kelletia kelleti (Forbes)	R	..	..	..	..	..	C	R	..	..
Macron lividus (A. Adams)	..	..	..	..	..	V	..	V	..	..
"Nassa" delosi Woodring	..	R	..	..	..	..	..	..	..	..
"Nassa" fossata (Gould)	A	A	S	S	V	V	C	C	..	C
"Nassa" mendica Gould	..	C	..	..	..	..	..	..	..	..
"Nassa" mendica cooperi Forbes	R	R	..	..	V	V	C	R	..	..
"Nassa" perpinguis Hinds	R	A	A	C	..	..	A	R	..	C
Mitrella carinata (Hinds)	R	R	..	..	V	V	C	C	C	C
Mitrella carinata gausapata (Gould)	..	C	..	R	C	C	A	C	R	..
Amphissa cf. *A. undata* (Carpenter)	..	V	..	..	..	..	..	..	..	..
Amphissa versicolor Dall	..	V	..	..	C	V	R	C	R	..
Aesopus cf. *A. myrmecoon* Dall	..	..	..	..	V	..	..	..	..	..
Ceratostoma nuttalli (Conrad)	..	..	..	..	..	V	..	..	..	..
Jaton festivus (Hinds)	..	..	..	..	..	..	R	..	..	..
Maxwellia gemma (Sowerby)	..	..	..	..	..	V	V	..	..	..
Maxwellia santarosana (Dall)	..	..	..	..	..	..	R	..	..	..
Ocinebra foveolata (Hinds)	..	C	..	..	..	..	V	V	..	..
Ocinebra gracillima Stearns	..	..	..	..	..	..	..	..	V	..
Ocinebra interfossa Carpenter	..	..	..	..	R	C	V	R	R	..
Ocinebra interfossa beta (Dall)	..	..	..	..	V	..	V	..	V	..
Ocinebra poulsoni Carpenter	..	..	..	..	..	..	V	..	..	..
Nucella emarginata ostrina (Gould)	R	..	C	R	V	R	..	..	..	..
Stramonita biserialis (Blainville)	..	..	..	..	..	V	..	..	..	..
Acanthina lugubris (Sowerby)	R	R	R	..	R	C	C	R	C	..
Acanthina paucilirata (Stearns)	..	R	R	C	C	C	V	C	V	C
Acanthina spirata (Blainville)	C	A	A	A	V	..	C	R	..	C
Opalia chacei Strong	..	..	..	..	..	V	..	V	..	..
Opalia insculpta Carpenter	..	..	..	..	..	V	..	..	..	..
Epitonium indianorum (Carpenter)	..	V	..	..	..	..	..	..	..	..
Epitonium tinctum (Carpenter)	..	..	..	..	C	R	V	V	V?	..
Balcis rutila (Carpenter)	..	..	..	..	V	..	..	..	..	..
Balcis thersites (Carpenter)	..	..	..	..	V	V	..	R	..	..
Turbonilla almo Dall and Bartsch	..	..	..	..	V	..	..	..	..	..
Turbonilla aresta Dall and Bartsch	..	..	..	..	..	..	V	..	..	..
Turbonilla buttoni Dall and Bartsch	..	..	..	..	..	..	V	..	..	..
Turbonilla tenuicula (Gould)	..	..	..	..	V	R	V	R	V	..
Turbonilla spp.	..	..	..	..	R	V	..	V	..	..
Odostomia cf. *O. donilla* Dall and Bartsch	..	..	..	..	..	V	..	..	..	..
Odostomia cf. *O. io* Dall and Bartsch	..	..	..	..	..	..	..	V	..	..
Odostomia phanea Dall and Bartsch	..	..	..	..	..	V	..	..	..	..
Odostomia cf. *O. phanella* Dall and Bartsch	..	..	..	..	..	..	..	V	..	..

TABLE 2.—Continued

	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Odostomia trachis Dall and Bartsch	..	..	..	..	..	..	V	..	V	..
Odostomia virginalis Dall and Bartsch	..	..	..	..	V	..	V	V	C	..
Odostomia spp.	..	..	..	..	R	..	R	V	..	..
Bursa californica (Hinds)	C	C	A	A	..	..	C	R	..	..
Zonaria spadicea (Swainson)	..	..	..	..	..	V	V	..	..	..
Pusula californiana (Gray)	..	..	..	..	R	R	R	V	..	..
Erato columbella Menke	..	..	..	..	V	V	V	..	..	..
Erato vitellina Hinds	..	..	..	..	..	R	..	..	..	..
Bittium interfossa Carpenter	..	..	..	..	..	..	V	R	V?	..
Bittium purpureum Carpenter	..	..	..	..	..	V	..	..	..	..
Seila montereyensis Bartsch	..	..	..	..	V	R	V	V	..	..
Cerithiopsis antefilosa Bartsch	..	..	..	..	..	..	..	V	..	..
Cerithiopsis cf. *C. antemunda* Bartsch	..	..	..	..	V	..	..	..	..	..
Cerithiopsis carpenteri Bartsch	..	..	..	..	V	..	..	..	..	..
Cerithiopsis diegensis Bartsch	..	..	..	..	..	..	R	V	..	..
Cerithiopsis spp.	..	..	..	..	R	V	V	V	..	..
Triphora hemphilli (Bartsch)	..	..	..	..	V	..	..	..	..	..
Triphora cf. *T. pedroana* (Bartsch)	..	..	..	..	..	V	V	..	..	..
Nodulus kelseyi Bartsch	..	..	..	..	R	..	..	..	..	..
Amphithalamus tenuis Bartsch	..	..	..	..	R	..	..	..	..	..
Alvania acutelirata (Carpenter)	..	..	..	..	..	..	..	V	..	..
Alvania purpurea Dall	..	..	..	..	C	..	..	..	V	..
Rissoina cleo Bartsch	..	..	..	..	R	..	..	..	..	..
Turritella cooperi Carpenter	..	R	R?	..	..	..	..	..	..	..
Aletes squamigerus Carpenter	C	..	..	R	R	C	C	C	C	C
Spiroglyphus lituella (Morch)?	..	..	..	..	R	R	R	R	R	..
Petaloconchus cf. *P. complicatus* Dall	..	..	..	..	..	..	..	..	V	..
Caecum californicum Dall	..	..	..	..	C	..	..	V	V	..
Caecum licalum Bartsch	..	..	..	..	..	..	..	V	..	..
Fartulum hemphilli Bartsch	..	..	..	..	A	..	..	V	R	..
Fartulum occidentale Bartsch	..	..	..	..	R	..	..	R	..	..
Fartulum orcutti (Dall)	..	..	..	..	A	..	V	V	A	..
Littorina planaxis Philippi	C	..	C	R	A	A	R	R	A	..
Littorina scutulata Gould	C	C	A	A	R	S	A	S	S	..
Lacuna carinata Gould	..	..	..	..	R	..	C	C	..	C
Lacuna unifasciata Carpenter	..	..	..	..	R	R	R	V	V	..
Barleeia haliotiphila Carpenter	..	..	..	..	C	..	R	C	R	..
Barleeia oldroydi Bartsch	..	..	..	..	V	..	..	R	..	..
Truncatella stimpsoni Stearns	..	..	..	..	R	..	..	..	..	..
Assiminea translucens (Carpenter)	..	..	..	..	C	R	..	..	R	..
Hipponix antiquatus (Linnaeus)	A	..	..	C	C	C	C	C	C	..
Hipponix tumens Carpenter	..	..	..	..	V	R	C	V	R	..
Crepidula adunca Sowerby	..	R	..	..	..	..	R	R	V	..
Crepidula coei Berry	R	R	..	..	..	V	R	R	V	..

Table 2.—Continued

	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Crepidula nummaria Gould	R	..	..	R	C	R	R	R	R	..
Crepidula onyx Sowerby	R	..	..	..	..	..	R	V?	..	..
Crepipatella lingulata (Gould)	..	..	..	..	V	C	R	R	R	..
Neverita reclusiana alta Arnold	R	C	..	..	..	..	A	C	V	..
Neverita ? sp	..	..	..	..	..	..	..	..	..	C
Euspira lewisi (Gould)	C	R	A	C?	..	..	V	..	..	..
Velutina laevigata (Linnaeus)	..	..	..	..	V	..	..	..	..	..
Acmaea asmi (Middendorff)	..	..	..	..	C	C	R	R	R	..
Acmaea digitalis Eschscholtz	C	C	R	A	..	C	V	V	C	..
Acmaea insessa (Hinds)	..	R	..	R	V	C	V	V	V	..
Acmaea limatula Carpenter	R	..	..	..	R		R	R	C	..
Acmaea mitra Eschscholtz	..	..	..	R	V	R	R	R	C	C
Acmaea paleacea Gould	..	..	..	..	V	V	R	V	V	..
Acmaea pelta Eschscholtz	C	V	..	..	..	V	..	V	R	..
Acmaea pelta navicelloides Dall	..	..	..	..	..	C	..	..	..	..
Acmaea cf. *A. persona* Eschscholtz	..	..	..	..	..	V	..	..	..	..
Acmaea persona strigatella Carpenter	..	R	..	..	V	..	V	V	..	..
Acmaea scabra (Gould)	..	R	..	..	A	C	C	C	C	..
Acmaea scutum Eschscholtz	R	V	..	V?	..	C	..	..	..	..
Lottia gigantea (Gray)	..	..	..	..	..	V	V	..	R	..
Tricolia cf. *T. compta* (Gould)	R	..	..	..	..	..	..	..	..	..
Tricolia pulloides (Carpenter)	..	..	..	..	R	..	C	R	..	..
Pomaulax undosus (Wood)	..	..	..	..	..	..	R	V	..	..
Homalopoma carpenteri (Pilsbry)	..	..	..	..	C	C	..	R	C	..
Norrisia norrisi (Sowerby)	..	..	..	..	C	V	C	V	R	..
Halistylus pupoideus (Carpenter)	..	..	..	..	..	..	..	V	..	..
Tegula aureotincta (Forbes)	..	..	..	..	R	..	V	..	V	..
Tegula brunnea (Philippi)	..	..	..	..	..	..	R	..	C	..
Tegula brunnea fluctuata (Dall)	..	..	..	..	..	..	..	V	V	..
Tegula funebralis (A. Adams)	S	C	R	C	C	C	A	A	A	C
Tegula gallina (Forbes)	..	..	..	..	C	..	..	..	..	..
Tegula gallina multifilosa (Stearns)	..	..	..	..	R	R	..	V	C	..
Tegula ligulata (Menke)	..	..	..	..	..	..	V	..	..	..
Tegula marcida (Gould)	..	..	C	..	..	..	..	..	..	..
Tegula marcida subsp. nov.?	..	..	..	..	..	..	V	..	..	..
Calliostoma doliarium (Holten)	..	V	R	..	..	..	R	V	..	..
Calliostoma gemmulatum Carpenter	..	..	..	..	..	..	..	V	..	..
Calliostoma ligatum (Gould)	R	..	R	R	V	..	V	V	..	..
Pupillaria parcipictus (Carpenter)	..	..	..	..	V	..	..	..	..	..
Vitrinella oldroydi Bartsch	..	..	..	..	V	..	..	..	..	..
Pseudorotella cf. *P. bibbiana* (Dall)	..	..	..	..	V	..	..	..	..	..
Pseudorotella invallata (Carpenter)	..	..	..	..	R	..	..	..	..	..
Pseudorotella supravallata (Carpenter)	..	..	..	..	C	V	..	..	R	..
Haliotis cracherodi Leach	C	..	..	..	R	V	V	R	C	..

TABLE 2.—Continued

	3161	3160	2720	2719	2715	2716	2718	2717	3162	3569
Haliotis rufescens Swainson	..	..	..	..	..	..	..	V	..	..
Haliotis sp.	..	..	..	R	..	..	..	..	..	..
Fissurella volcano Reeve	C	..	..	..	R	C	R	C	C	..
Megatebennus bimaculata (Dall)	..	V	..	C	R	R	..	..	..	..
Lucapinella callomarginata Dall	..	..	..	..	..	..	..	V	..	..
Diodora aspera (Eschscholtz)	..	..	..	R	V	R	V	V	..	..
AMPHINEURA										
Tonicella cf. *T. lineata* (Wood)	..	..	..	..	R	..	V	..	..	..
Nuttallina californica (Reeve)	..	..	..	..	V	..	..	..	..	..
Mopalia ciliata (Sowerby)	..	..	..	..	..	V	..	..	..	..
Mopalia hindsi (Sowerby)	..	..	..	R	..	..	..	..	..	..
Mopalia muscosa (Gould)	..	..	..	..	R	V	V	V	..	..
Mopalia ? sp.	..	..	..	..	..	..	..	..	..	C
Cryptochiton stelleri (Middendorff)	..	..	..	R	..	..	..	..	..	..
Stenoplax acrior (Carpenter)	..	..	..	..	V	..	..	V	..	..
Stenoplax conspicuus (Carpenter)	..	..	..	..	V	..	..	..	..	..
Lepidozona pectinulatus (Carpenter)	..	..	..	..	V	V	..	..	..	..
Callistochiton crassicostatus Pilsbry	..	..	..	..	..	V	R	V	..	..
Callistochiton palmulatus mirabilis Pilsbry	..	..	..	..	..	V	..	V	..	..

HABITATS AND SUGGESTED DEPOSITIONAL ENVIRONMENTS

Faunas from seven of the localities are so similar in their ecologic character that they may be discussed as a unit. The fauna at locality 3569, with 16 identified species, is too small for comparison; and the faunas from localities 2716 and 3162, discussed below, differ only quantitatively from the other assemblages in their ecologic character.

In the seven similar faunas, between 40 and 50 per cent of the species at each locality live today most commonly in shallow water along exposed coasts. Many are essentially intertidal types usually living on rocks washed or sprayed by waves; *Mytilus californianus, Nucella emarginata ostrina, Littorina planaxis, L. scutulata, Lottia gigantea,* several species of *Acmaea* and *Tegula,* and several of the chitons represent this group. A few other forms live intertidally or subtidally in sandy areas along exposed coasts, as *Tivela stultorum, Amiantis callosa,* and *Donax gouldi.*

In these seven faunas, about 20 to 30 per cent of the species have a wide ecological range today and are not uncommon along exposed rocky coasts in shallow water. These include *Leptopecten latiauratus, Macoma secta, Conus californicus, Olivella biplicata,* and *"Nassa" perpinguis.* The remaining species, about 30 per cent of the fauna at each locality, are those that live most commonly in shallow waters of embayments or offshore below most wave action along exposed coasts. Among this group are *Nuculana taphria, Macoma nasuta, Spisula hemphilli, Ocinebra poulsoni, Balcis thersites, Bursa californica,* and *Euspira lewisi.*

The collections from locality 2716, the upper unit at Punta Descanso, and from locality 3162, near the rear of the terrace at Río Morro, contain fewer quiet-water species (10 to 20 per cent) and more exposed-rocky-shore species (60 to 70 per cent) than the faunas discussed above. Nearly the entire fauna from locality 3569 is composed of shallow-water exposed coast and ecologically ubiquitous species.

The preponderance of shore types at all localities suggests deposition along a coast much like the present one, with alternating short rocky and sandy stretches. Many specimens of quiet-water species, which probably were transported shoreward by storm waves, are broken and worn. All faunas probably were deposited in less than 10 fathoms of water; localities 2716 and 3162 may represent shore deposits.

Geographic Ranges and Suggested Temperatures

A total of 22 species and subspecies, from all localities combined, are not known to live at present at the latitude of their Pleistocene occurrence. Of these, 19 live only to the north and 3 live only to the south. They are listed in table 3, together with the nearest known living occurrence of each. A summary of their fossil occurrence by localities is given in table 1.

The presence of a small northern shallow-water element at all localities suggests that sea-surface temperatures were locally cooler than at present along northwestern Baja California. However, the rare southern shallow-water element suggests that water slightly warmer than at present was available at least intermittently in the area.

CLIMATIC SIGNIFICANCE OF THE FAUNAS

A striking feature of late Pleistocene faunas from southern California and Baja California is the contrast in thermal significance (as interpreted from the present ranges of species) between exposed and protected shallow-water faunas (Valentine 1954). Assemblages dominated by exposed-coast or offshore species, such as those recorded here, commonly include northern, cool-water species, whereas southward-ranging species are rare or absent. In contrast, assemblages dominated by protected shallow-water species, especially assemblages from ancient embayments, include many more warm-water than cool-water species. Emerson (1956) reviewed several late Pleistocene faunas to illustrate this point. This relation of temperature to habitat, particularly to degree of protection or exposure, formed the basis of a recently suggested model of Pleistocene marine climates in the region (Valentine 1955). It was proposed that increased temperature contrasts — indicated by cool, exposed and warm, protected faunas that are essentially contemporaneous — might be explained as a result of increased oceanic and atmospheric circulation during glacial times. The cool-water elements in exposed-coast faunas were attributed to increased flow and lower temperatures of upwelling waters. Higher temperatures necessary to support southern species may have been due to a general warming of the ocean or to the introduction of warm southern water by northward-flowing currents.

TABLE 3. Nearest living occurrence of locally extinct species

Most range and habitat data are from Berry (1922), Keen (1937), Burch *et al.* (1944-46), and U. C. L. A. collections.

Species	Nearest known occurrence
Northern species	
Glycymeris profunda (Dall)	Off Redondo Beach
Irus lamellifer (Conrad)	San Diego
Siliqua patula (Dixon)	Pismo Beach
Mitromorpha aspera (Carpenter)	Coronado Islands
Cancellaria cooperi Gabb	Coronado Islands
Mitra idae Melvill	Cortez Bank
"Nassa" delosi Woodring	Balboa Beach[1]
Ocinebra interfossa beta (Dall)	So. Coronado Is.
Opalia chacei Strong	San Diego
Odostomia phanea Dall & Bartsch	San Diego
Lacuna carinata Gould	San Diego
Barleeia oldroydi Bartsch	Coronado Islands
Velutina laevigata (Linnaeus)	Cayucos
Tegula brunnea (Philippi)	Santa Barbara Is.
Tegula brunnea fluctuata (Dall)	San Nicolas Is.
Calliostoma doliarium (Holten)	San Diego
Calliostoma ligatum (Gould)	San Diego
Cryptochiton stelleri (Middendorff)	Channel Islands
Callistochiton palmulatus mirabilis Pilsbry	San Diego
Southern species	
Ostrea megodon Hanley	Scammons Lagoon[2]
"Chione" picta Dall	Magdalena Bay
Acanthina lugubris (Sowerby)	Todos Santos Bay

[1]Record by E. P. Chace, personal communication, 1956.

[2] Or perhaps farther south. See Woodring, Bramlette, and Kew 1946, p. 81.

DESCRIPTION OF FOSSIL LOCALITIES

Locality numbers in the following paragraphs are those of the Department of Geology, University of California, Los Angeles.

The two base maps available (fig. 1) are very generalized and do not always agree. Localities may most easily be found by reference to local coastal topography. The kilometer signs, although quite useful today, may be moved at a future date.

LOCALITY NO. 2715.—Unconsolidated pebble conglomerate with sand matrix, 3 feet thick, extending about 40 yards along the sea cliff approximately 5 miles south of the radio tower at Rosarito Beach, and about 0.3 mile north of kilometer 35 sign on Highway 1, Baja California, Mexico. Collected by Cunningham and Valentine, February, 1952.

LOCALITY NO. 2716.—Unconsolidated rubble with matrix of alluvium and broken shell, 3 feet thick, directly overlying pebbly sand at locality 2715. Collected by Cunningham and Valentine, February, 1952.

Locality no. 2717.—Sandy rubble exposed in sea cliff approximately 6.4 miles south of the radio tower at Rosarito Beach, and about 0.3 mile south of kilometer 36 sign on Highway 1, Baja California, Mexico. Collected by Cunningham and Valentine, February, 1952.

Locality no. 2718.—Sandy rubble exposed in sea cliff approximately 5.7 miles south of the radio tower at Rosarito Beach, at kilometer 36 sign on Highway 1, Baja California, Mexico. Collected by Cunningham and Valentine, February, 1952.

Locality no. 2719.—Unconsolidated pebble conglomerate exposed in sea cliff approximately 2.2 miles south of the radio tower at Rosarito Beach, at kilometer 30 sign on Highway 1, Baja California, Mexico. Collected by Valentine, December, 1952.

Locality no. 2720.—Sandy rubble exposed in sea cliff at the second small re-entrant in first sea cliffs south of the radio tower at Rosarito Beach, Baja California, Mexico. Collected by Valentine, December, 1952.

Locality no. 3160.—Unconsolidated cobble conglomerate exposed in low sea cliff approximately 5.2 miles north of the radio tower at Rosarito Beach, Baja California, Mexico. Bearing from locality to south end of South Coronado Island, 263° true. Collected by Cunningham and Valentine, January 1952.

Locality no. 3161.—Unconsolidated cobble conglomerate exposed in sea cliff approximately 8 miles north of the radio tower at Rosarito Beach, Baja California, Mexico. Bearing from locality to south end of South Coronado Island, 238° true. Collected by Cunningham and Valentine, January, 1952.

Locality no. 3162.—Unconsolidated pebble conglomerate exposed in road cut of Highway 1, 50 yards south of the bridge across Río Morro, Baja California, Mexico. Collected by Valentine, November, 1952.

Locality no. 3569.—Unconsolidated cobble conglomerate exposed in gully 20 feet inland from sea cliff, approximately 4½ miles south of the mouth of Río Morro, and about 150 yards north of kilometer 45 sign on Highway 1, Baja California, Mexico. Collected by Valentine, November, 1952.

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Fig. 2. Fossiliferous terrace deposits on the north side of Punta Descanso (localities 2715, 2716), looking southward.

Marine conglomerates and pebbly sands overlie Pliocene (?) basalt, on which the terrace platform is eroded, and are in turn overlain by fossiliferous alluvial rubble. A narrow bench is developed on the slightly more resistant sands.

FIG. 3. Terrace deposits in upper central portion of fig. 2.

Marine sediments (by the mattock) have a light-colored sandy matrix, whereas the matrix of the upper unit (by the hammer) is dark unsorted alluvium and rubble.

FIG. 4. Terrace platform overlain by unsorted fossiliferous deposit, exposed in road cut just south of Río Morro (locality 3162).

Fig. 5. Detail of fossiliferous horizon in fig. 4, showing massive unsorted sediments overlying the basalt.

Fig. 6. Fossiliferous lens of marine terrace sediment, left foreground, exposed in gully 20 feet inland from sea cliff, about 4½ miles south of Río Morro (locality 3569).

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TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. XII, No. 17, pp. 309, 310, fig. 1 SEPTEMBER 25, 1957

TYPE MATERIAL OF EUCALODIUM ORCUTTI DALL (GASTROPODA: PULMONATA) FROM OAXACA, MEXICO

BY

ROBERT J. DRAKE
Department of Zoology, University of Arizona

Eucalodium (*Anisospira*) *orcutti* was described by Dall (1910) from specimens collected by Charles Russell Orcutt "at some hot springs near Rio Verde, Oaxaca." The type is No. 212319 in the United States National Museum. Orcutt (1915) told of making botanical collections in northern and eastern Oaxaca in February and April of 1910. It is probable that the specimens were collected near the river and town of Río Verde in the eastern part of the state, along the Isthmian Railroad. There is another Río Verde in western Oaxaca but there is no indication that he visited that area, at least in that year.

After Orcutt's death, his large cabinet of shells was deposited in the San Diego Museum of Natural History. The collections include, as No. 7615, ten specimens of *Eucalodium orcutti* from "Rio Verde, Oaxaca." Since Dall cited specimens in the Orcutt collection in addition to the type, and since there are no other specimens of the species in the Museum collection, it is probable, despite the less precise locality designation, that this set is part of the type collection.

Since *Eucalodium orcutti* apparently has not been illustrated, two specimens are shown in fig. 1. For the larger shell illustrated, which is the largest in the lot, measurements are as follows: height, 54 mm.; width of the spire, 4 mm.; greatest width, 12 mm.; height of the aperture, 7 mm.; width of the aperture, 8 mm. There are 20½ whorls, with the decollation at 9½ whorls. Of the other nine shells in the lot, seven are decollated at 9½ whorls, one at 8½ whorls, and one at 10½ whorls.

Charles Russell Orcutt (1864-1929) was a professional collector of natural history materials (Jepson 1929). From the early 1880's to the 1920's he collected widely in the southwestern United States and in México. The extent of his contribution to the malacology of México has never been assessed.

Study to locate museum collections of Mexican nonmarine mollusks was supported by American Philosophical Society grants (Penrose Fund) in 1951

and 1952. Research at the San Diego Museum of Natural History was made possible by the Bache Fund of the National Academy of Sciences in 1954. That study included the urocoptid portions of the Orcutt and H. N. Lowe collections permanently deposited there. Help with references and localities was kindly given by Drs. Reid Moran and Carl L. Hubbs.

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Fig. 1. *Eucalodium orcutti* Dall

Shells from Rio Verde, Oaxaca; No. 7615 in the collection of the San Diego Museum of Natural History; approximately ×1½. Photograph by Robert J. Drake.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOL. XII, No. 18, pp. 311-318, figs. 1-4 OCTOBER 16, 1958

THE NORTH AMERICAN SPECIES OF HESPERUS FAUVEL, WITH DESCRIPTIONS OF TWO NEW SPECIES (COLEOPTERA; STAPHYLINIDAE)

BY

IAN MOORE

Associate in Entomology, San Diego Museum of Natural History

The genus *Hesperus* was based by Fauvel (1874) on the European species *Staphylinus rufipennis* Gravenhorst. He included in the genus two conspicuous and well-known eastern American species, *Staphylinus baltimorensis* Gravenhorst (1802) and *S. apicialis* Say (1834), both of which had previously been removed to *Philonthus*. It is surprising at this late date to find two new large and even more conspicuous species in the North American fauna, one from Ohio and the other from Arizona. This discovery would seem to indicate either that the new species are quite rare or that the American staphylinid fauna is poorly known. The two new species are so distinctive that, although each is represented in our material by only a single specimen, I do not hesitate to describe them.

Hesperus is a widespread genus with many tropical species but only a few in temperate regions. Nearly one hundred species have been described from tropical Africa, Asia, the East Indies, and Australia. Of the four palearctic species, only one is found in Europe. Although only six species are known from tropical America, two of these from Guatemala and four from South America, it is likely that many more will be found when these regions are fully explored. In 1936 Scheerpeltz published a key to the six Neotropical and two Nearctic species.

The genus *Hesperus* can be distinguished from all other genera of the North American Staphylininae except *Belonuchus* by the elongate, slender palpi, with the last segment of the maxillary palpus at least five times as long as wide and slightly truncate at the tip. *Hesperus* differs from *Belonuchus* in lacking the row of strong setae (often called "spines") that in *Belonuchus* usually arm the posterior femora internally. The North American species of *Hesperus* further differ from those of *Belonuchus* in having the first four segments of the anterior tarsus strongly dilated in each sex, whereas in the latter genus the anterior tarsus is slender (in females) or only slightly dilated (in males).

Hesperus arizonicus sp. nov.

DESCRIPTION OF HOLOTYPE (male). — *Color* largely ferruginous; fourth to tenth antennomeres and apex of fifth abdominal segment dusky; most of basal half of each elytron, except for the suture and a narrow basal strip, covered by a large yellow spot; entire sixth and bases of first five abdominal segments yellow. *Head* much broader than long, slightly broader than pronotum; dorsal surface with punctures coarse and very close, generally separated by less than one-half of their width except in a small central area anteriorly, almost coalescing at the sides, the ground sculpture a very feeble micro-reticulation; ventral surface impunctate, but with a feeble micro-reticulation throughout. *Antennae* shorter than head and pronotum, the first segment as long as next three together, the second twice as long as wide, the third three times as long as wide and 1.5 times as long as second, the remaining segments gradually shorter but narrower after the ninth so that none of them is transverse. *Pronotum* subquadrate, a little longer than wide, the apex gently arcuate, the anterior angles rounded, the sides thence gently arcuate and slightly sinuate before the rounded posterior angles, the base arcuate; surface as coarsely punctate as the head but more sparsely, the punctures generally separated by about their width, a central strip impunctate and impressed in a broad irregular groove throughout most of the length, the ground sculpture a feeble micro-reticulation. *Elytra* quadrate, wider and longer than pronotum, the humeri broadly rounded, the sides straight and hardly divergent to the narrowly rounded apical angles, the apex conjointly emarginate in a gentle arc in central three-fifths; surface finely, rather roughly, and moderately closely punctate. *Abdomen* narrower than elytra, tapering only slightly to apex; dorsal and ventral surfaces about as finely punctate as elytra but more sparsely and not so roughly; without ground sculpture; last sternite emarginate in its central third in a gentle arc with rounded outer angles, the emargination wider than deep. *Length* 15 mm.

FEMALE. — Unknown.

TYPE. — The unique type collected at Patagonia, Arizona, on January 4, 1938, by Dr. E. C. Van Dyke. It is deposited in the California Academy of Sciences, San Francisco.

DIAGNOSIS. — Among the North American species this large colorful insect is very distinct in its markings and color, and particularly in the punctation of the head, which is most like that of *H. stehri,* but with even larger and more crowded punctures. This species differs from the ferruginous Neotropical species by the yellow markings of the elytra and abdomen and by its larger size.

Hesperus stehri sp. nov.

DESCRIPTION OF HOLOTYPE (male). — *Color* black except eleventh antennomere and tarsi, which are dark rufous, and apex of abdomen, which is bright rufous. *Head* quadrate, broader than long, wider than pronotum, densely punctate dorsally except in a very narrow central strip, the punctures of disk separated by little more than their diameters, becoming closer toward the apex and sides until they nearly coalesce in places; dorsally without ground sculpture; ventrally with a few scattered punctures and a ground sculpture of very fine diagonal lines near the gular sutures. *Antennae* shorter than head and pronotum, the first segment widest, almost as long as next three together, the second about twice as long as wide, the third not quite twice as long as second and about as wide, the fourth and fifth slightly elongate, the sixth to tenth about as wide as long, the eleventh very little longer than wide. *Pronotum* about as wide as long, narrower than but about as long as head; apex nearly straight, but slightly sinuate before anterior angles, the angles narrowly rounded, the sides arcuate in anterior half, thence sinuate to rounded posterior angles, the base slightly arcuate; punctures sparse and fine except in a narrow impunctate central line, closer toward sides; without ground sculpture. *Elytra* about as long as wide conjointly, the sides straight from broadly rounded humeri to narrowly rounded apical angles, the apex shallowly emarginate conjointly in central three-fifths; punctures fine and a little closer than those of pronotum; without ground sculpture. *Abdomen* narrower than elytra, tapering to apex which is about one-half the basal width; punctures dorsally about as close as on elytra but coarser at base; ventrally a little more closely punctured; without ground sculpture; last sternite apically emarginate in its central fourth, the emargination evenly arcuate with rounded outer angles, about as wide as deep. *Length* 15 mm.

FEMALE. — Unknown.

TYPE. — A single specimen collected by Dr. William C. Stehr at Ash Cave, Hocking County, Ohio on May 5, 1934. With the kind permission of Dr. Stehr, the type has been deposited in the California Academy of Sciences, San Francisco.

DIAGNOSIS. — This species is colored like *H. apicialis* but is larger, with a wider head, differently shaped pronotum, relatively wider elytra, and narrower abdomen. It is very distinct in the close set punctures of the head and the lack of ground sculpture of the head and pronotum. It differs from all of the Neotropical species in its larger size and in its color. It is a pleasure to name it for Dr. William C. Stehr, who collected it.

Hesperus baltimorensis (Gravenhorst)

Staphylinus baltimorensis Gravenhorst 1802, p. 163; 1806, pp. 112, 122; Say 1834, p. 451.

Philonthus baltimorensis Erichson 1840, p. 503; Gemminger & Harold 1868, p. 585; Horn 1884, p. 220.

Hesperus baltimorensis Fauvel 1874a, p. 200; 1874b, p. 426; Blatchley 1910, p. 390; Bernhauer & Schubert 1914, p. 364; Scheerpeltz 1936, p. 490.

DESCRIPTION. — *Color*: head and thorax black; elytra, abdomen and legs dark rufous. *Head* subquadrate with the basal angles so broadly rounded as to be obsolete; dorsally very sparsely punctate except on the impunctate central area, the punctures separated by four to five times their diameters; ground sculpture of fine obsolescent strigulose lines; ventrally almost impunctate, with somewhat stronger ground sculpture. *Antennae* shorter than head and pronotum, the first segment a little longer than second and third together, the second almost twice as long as wide, the third 1.5 times as long as second, the fourth to sixth quadrate, the seventh to tenth transverse, the eleventh a little longer than wide. *Pronotum* subquadrate, narrower and longer than head, one-third longer than wide, the anterior angles narrowly rounded, the sides gently arcuate and very slightly sinuate before the narrowly rounded basal angles, the base strongly arcuate; punctures sparse and not coarse; ground sculpture almost effaced. *Elytra* wider and slightly longer than pronotum, conjointly about as long as wide, the sides straight from the broadly rounded humeri to the rounded apical angles, the apex conjointly emarginate in a gentle arc in the central three-fifths; surface rather roughly punctate, a little more coarsely so than the pronotum and twice as closely, without ground sculpture. *Abdomen* narrower at base than elytra, tapering to apex to about half the basal width, the punctation as on elytra; ventral surface similar to dorsal. *Length* 10 to 13 mm.

MALE. — Last sternite apically emarginate in its central third, the emargination evenly arcuate with narrowly rounded outer angles, about as deep as wide. Head a little wider than long, a little wider than pronotum.

FEMALE. — Last sternite entire. Head not wider than long, not wider than pronotum.

TYPE. — "America septentr." Probably in the Zoologische Museum, Berlin.

DISTRIBUTION. — Has been recorded from the middle and southern states and from Indiana. I have seen specimens from New York, Alabama and Missouri.

DIAGNOSIS. — This species differs in color from the other North American species. The head is even more sparsely punctate than that of *H. apicialis* and the antennae are more robust.

Hesperus apicialis (Say)

Staphylinus apicialis Say 1834, p. 451; 1869, p. 566.

Philonthus haematurus Erichson 1840, p. 504.

Philonthus apicalis Erichson 1840, p. 931; Horn 1884, p. 220.

Philonthus apicialis Gemminger & Harold 1868, p. 585.

Hesperus apicalis Fauvel 1874a, p. 200; 1874b, p. 426; Blatchley 1910, p. 390; Leng 1920, p. 108; Scheerpeltz 1936, p. 490.

Hesperus apicialis Bernhauer & Schubert 1914, p. 364. [In this work Horn is erroneously credited with the spelling "*apicialis*".]

DESCRIPTION. — *Color* black except for eleventh antennomere and tarsi, which are dark rufous, and last two or three abdominal segments, which are dark or bright rufous. *Head* subquadrate, with posterior angles very broadly rounded, the disk broader than long, slightly wider than pronotum; sparsely punctate dorsally, the punctures not very coarse, separated by about three times their diameter, a little more closely punctate toward sides; with a ground sculpture of very fine obsolescent strigulose lines; ventral surface much more sparsely punctate, but ground sculpture much stronger, particularly toward gular sutures. *Antennae* shorter than head and pronotum, the first segment thickest, as long as next two combined, the second shorter than third, twice as long as wide, the third three times as long as wide, as long as next two combined, the fourth to eighth just perceptibly elongate, the ninth to eleventh more slender and hence relatively more elongate. *Pronotum* one-third longer than wide, longer and narrower than head, the anterior angles broadly rounded into the sides, thence very gradually arcuate to the broadly rounded posterior angles, the base evenly arcuate, the surface punctation and sculpture very similar to those of dorsal surface of head, with a central impunctate strip the entire length. *Elytra* conjointly a little wider than head, a little longer than wide, the humeral angles broadly rounded, the sides nearly straight and slightly diverging to near the rounded apical angles, the apices shallowly emarginate conjointly in central three-fifths; surface twice as densely punctate as head but somewhat more finely so, the punctures becoming a little closer and somewhat aspirate laterally, without ground sculpture. *Abdomen* narrower than elytra, gradually tapering to apex, which is about one-half as wide as base; dorsal surface with punctures of basal segments closer than those of head but sparser than those of elytra, gradually sparser apically until no closer than on head, the punctures aspirate and elongate; ground sculpture lacking; ventral surface similarly punctate except for closer, coarser punctation at bases of anterior segments, with traces of strigulose ground sculpture basally. *Length* 9 to 11 mm.

MALE. — Last sternite apically emarginate in its central fourth, the emargination evenly arcuate, with rounded outer angles, about as deep as wide. Head wider than long, slightly wider than pronotum.

FEMALE. — Last sternite entire. Head hardly wider than pronotum, very little wider than long.

TYPE. — "Inhab. United States." The holotype has been lost.

DISTRIBUTION. — This species has been recorded from Canada to Georgia and from Indiana. I have seen specimens from Ohio, Missouri and Alabama.

DIAGNOSIS. — In color this species resembles only *H. stehri* among the North American species. *H. stehri* is larger and has a much more closely punctate head without ground sculpture.

It should be noted that Erichson (1840, p. 931) misspelled the name of this species and that his misspelling has been used by almost all subsequent workers.

KEY TO THE NORTH AMERICAN SPECIES OF HESPERUS

1a. Head closely punctate, the punctures mostly separated by their own width or less.
  2a. Head, pronotum, and elytra ferruginous.....*H. arizonicus*
  2b. Head, pronotum, and elytra black.....*H. stehri*

1b. Head sparsely punctate, the punctures mostly separated by more than twice their width.
  3a. Elytra and abdomen rufous.....*H. baltimorensis*
  3b. Elytra and base of abdomen black.....*H. apicialis*

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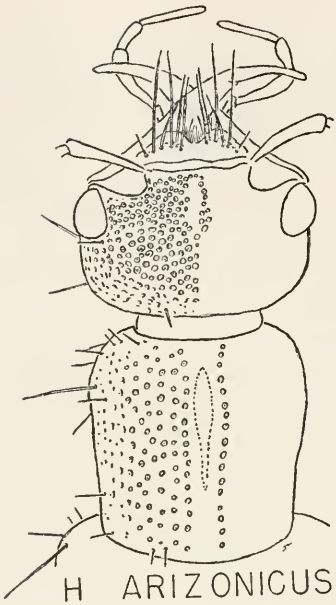

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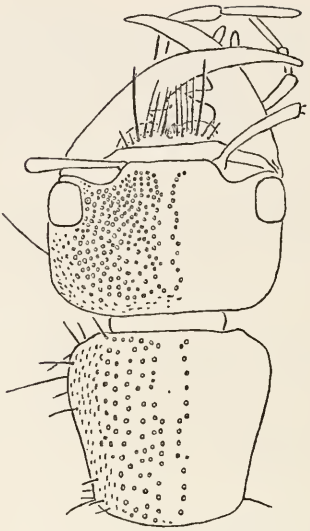
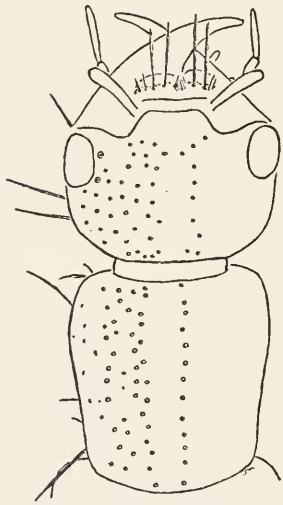


H. STEHRI



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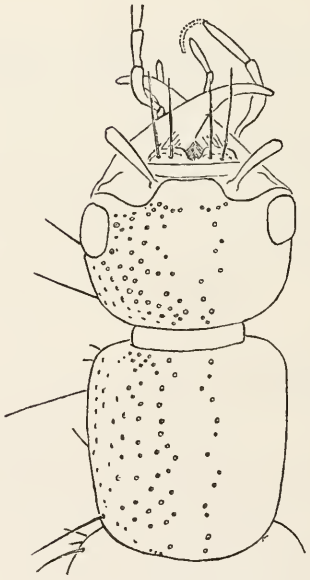

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THE MARINE MOLLUSCAN FAUNA OF GUADALUPE ISLAND, MEXICO

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A NEW MOLLUSK FROM SAN FELIPE, BAJA CALIFORNIA

BY

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SAN DIEGO, CALIFORNIA

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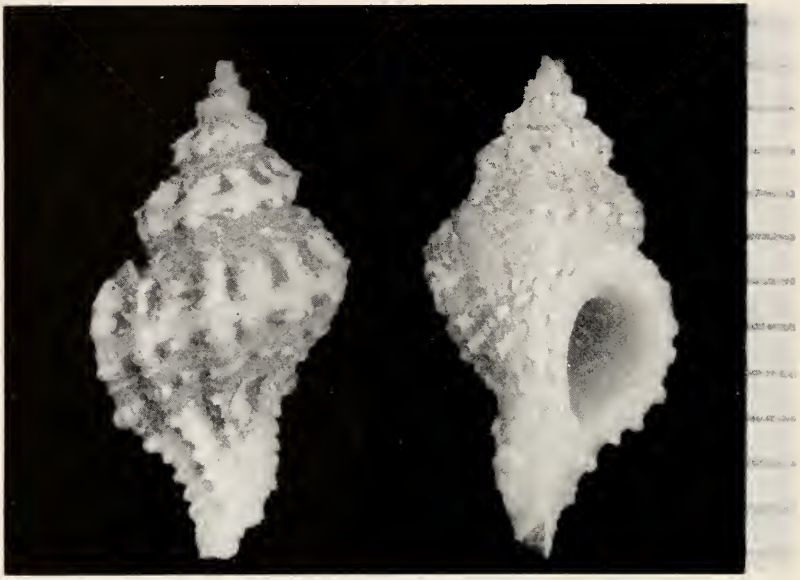

FIG. 1. *Ocenebra seftoni* sp. nov. Holotype (left) and paratype. Millimeter scale at right.

THE MARINE MOLLUSCAN FAUNA OF GUADALUPE ISLAND, MEXICO

BY

E. P. Chace

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INTRODUCTION

Guadalupe Island is 250 statute miles south-southwest of San Diego and 162 miles off the coast of Baja California. The island is 22 miles long and 4 to 6 miles wide. The highest point, 4257 feet above sea level, rises some 16,000 feet above the floor of the ocean. Thus the island is surrounded by deep water.

The part of the island above sea level is volcanic in origin. Strong (1954) suggested from the character of the lava and the amount of disintegration that its geologic age might be Pliocene. Johnson (1953) reported a small fossil marine fauna probably of Upper Tertiary or Quaternary age. In 1957 Dr. Carl L. Hubbs found exposures of Pleistocene fossils near the high-tide line at several points around the island, and in December of that year he and the writer collected about 50 pounds of shells and matrix at three localities. This material, representing a warm-water fauna, is under study.

Strong and Hanna (1930) listed 87 species of marine mollusks from Guadalupe Island, collected mainly by an expedition of the California Academy of Sciences in 1925. Strong (1954) increased the number to 116 species on the basis of a collection of 82 species by M. Woodbridge Williams on an expedition of the Scripps Institution of Oceanography in 1946. Pilsbry (1927) treated the land and freshwater mollusks of the island.

Since 1945 Dr. Hubbs and his associates from the Scripps Institution have collected mollusks on several trips to the island. Some of this material was collected in the littoral zone, some was dredged, and some was brought up by divers. Most of this material has come to the San Diego Museum of Natural History, and it has now been identified except for some microscopic shells. Since this material includes 77 species not reported from the island before, it seems worth while to publish a new list.

FAUNAL RELATIONSHIPS

Since there are no protected bays on Guadalupe Island, the only littoral species are those of exposed habitats, such as *Littorina, Acmaea, Lottia,* and *Haliotis.* Most of the species listed are from deeper water.

Many species are represented in the collections by only one or two specimens each. Several species were found only in one dredge haul, which happened to hit a mud pocket; these include *Lima subauriculata, Leiomya scaber, Cuspidaria pectinata, Thracia squamosa,* and *Crenella megas.* And each big collection has added several species to the list. These facts suggest that sampling has been somewhat haphazard and that further collecting may add many species. Nevertheless, since eight collecting trips have yielded only 193 species of mollusks, the marine molluscan fauna of Guadalupe Island may be characterized as scanty.

Of the 193 species of marine mollusks known from Guadalupe Island, 149 species, or 77.2 percent, belong to the Southern California Fauna, though some of these extend as far south as Cedros Island or beyond. Twenty-one of these, or 10.9 percent, are not otherwise known south of San Diego. Thirty-four species or 17.6 percent, belong to the Panamic Fauna, occurring on the mainland between San Diego and Panama but apparently not north of San Diego. Three of these are known only from Guadalupe Island and Panama: *Bursa calcipicta* Dall, *Liotia heimi* Strong & Hanna, and *Crenella megas* Dall. (Distributional data are mostly from Keen [1937].)

As with the other terrestrial and marine biota of Guadalupe Island, the mollusks show some endemism. Ten species, or 5.2 percent of the marine molluscan fauna, are not known to occur elsewhere. These are:

Ocenebra seftoni Chace
Diastoma slevini Strong
Alabina jordani Strong
Rissoina guadalupensis Strong
Rissoina lowei Strong
Rissoina willetti Strong
Rissoella bakeri Strong
Astraea guadalupeana Berry
Haliotis californiensis Swainson
Glycymeris guadalupensis Strong

Only two species of brachiopods have been collected at Guadalupe Island. Both occur also in southern California.

Scharff (1911) believed that Guadalupe Island and the other islands off the west coast of North America were remnants of a large land mass reaching in the distant past from Alaska to Peru and extending a considerable distance west of the present coastline. He claimed that the flora and fauna of the islands supported this hypothesis. It is now generally believed, however, that Guadalupe Island is an oceanic island and that its biota has resulted from fortuitous dispersal. Since many of the molluscs are kelp dwellers or are associated with kelp, Strong and Hanna (1930) believed that much of the molluscan fauna had arrived on drifting kelp from the islands of southern California.

LIST OF MOLLUSKS AND BRACHIOPODS

With one or two exceptions, the systematic arrangement of this list is that of Strong (1954). Trips on which the various species were collected are indicated as follows— S: California Academy of Sciences in 1925; W: M. Woodbridge Williams in 1946; 50, 54, 55, 56, and 57: Scripps Institution in 1950, 1954, 1955, 1956, and 1957. Notes as to abundance are based only on the collections of 1950 to 1957.

GASTROPODA

UMBRACULIDAE

Tylodina fungina Gabb (W, 57). Two specimens in dredgings.
Umbraculum ovale Carpenter (57). Two specimens in dredgings.

ACTEONIDAE

Acteon punctocaelata (Carpenter) (54). Several specimens.

ACTEOCINIDAE

Acteocina angustior Baker & Hanna (S, W, 57). A few specimens.
Acteocina magdalenensis Dall (50, 57). A few specimens each trip.
Acteocina planata (Carpenter) (54). Nine specimens in dredgings.
Retusa harpa (Dall) (S, 50). Seven specimens in dredgings.

SCAPHANDRIDAE

Cylichna attonsa Carpenter (50). Eight specimens.

AKERATIDAE

Haminoea angelensis Baker & Hanna (54). One specimen.

SIPHONARIIDAE

Williamia peltoides (Carpenter) (S, W, 55). One specimen.

CONIDAE

Conus californicus Hinds (50, 54, 57). Apparently fairly common.

TURRIDAE

Kurtzia beta (Dall) (S).
Mangelia barbarensis Oldroyd (54). Fifteen specimens in dredgings.
Mangelia interlirata Stearns (W).
Mitromorpha crassaspera Grant & Gale (50). Three specimens.
Mitromorpha filosa (Carpenter) (W, 50, 54).
Philbertia crystallina (Gabb) (50).

MARGINELLIDAE

Cypreolina pyriformis (Carpenter) (S, W, 50, 54).
Cystiscus jewettii (Carpenter) (S, W, 57).
Cystiscus minor (C. B. Adams) (54). One specimen in dredgings.
Cystiscus politulus (Dall) (S, W, 54).
Hyalina californica (Tomlin) (S, W, 50, 57).

MITRIDAE

Mitra catalinae Dall (S).
Mitra fultoni E. A. Smith (54). One specimen in dredgings.

FASCIOLARIIDAE

Fusinus kobelti (Dall) (54, 57). One specimen each trip.

BUCCINIDAE

Cantharus lugubris (C. B. Adams) (54). Two specimens.

NASSARIIDAE

Nassarius insculptus (Carpenter) (W, 50, 54, 57).

COLUMBELLIDAE

Aesopus arestus Dall (S).
Aesopus eurytoides (Carpenter) (W, 50). Three specimens in dredgings.
Aesopus sanctus Dall (W).
Anachis subturrita Carpenter (S, W).
Mitrella carinata (Hinds) (50). Five specimens.
Parametaria duponti (Kiener) (50). One very small specimen.

MURICIDAE

Ceratostoma nuttallii (Conrad) (50, 57). Eight specimens in the two trips.
Maxwellia gemma (Sowerby) (50, 57). One specimen each trip.
Ocenebra gracillima (Stearns) (W).
Ocenebra poulsoni (Carpenter) (W).
Ocenebra seftoni Chace (50, 57). Five specimens.

THAISINAE

Acanthina lugubris (Sowerby) (W, 50, 54, 57) Common.

EPITONIIDAE

Epitonium sp. cf. *E. apiculatum* Dall (50). Three specimens.
Epitonium bellastriatum (Carpenter) (54). One specimen.
Epitonium californicum Dall (W).
Epitonium sp. cf. *E. columbianum* Dall (50). One specimen.
Epitonium sawinae Dall (50). Three specimens.
Turbonilla (Pyrgiscus) halidoma Dall & Bartsch (50).

JANTHINIDAE

Janthina globosa Blainville (50). Two small ones.

EULIMIDAE

Eulima californica (Bartsch) (50). Three specimens.

PYRAMELLIDAE

Odostomia (Miralda) aepynota Dall & Bartsch (W, S).
Odostomia (Menestho) amilda Dall & Bartsch (W).
Odostomia (Menestho) callipyrga Dall & Bartsch (55). One specimen.
Odostomia (Chrysallida) clementina Dall & Bartsch (W).
Odostomia (Chrysallida) deceptrix Dall & Bartsch (S).
Odostomia (Iolina) eucosmia Dall & Bartsch (S).
Odostomia (Ividella) navisa Dall & Bartsch (S, W).
Odostomia (Chrysallida) pulcia Dall & Bartsch (W).
Odostomia (Ivara) turricula Dall & Bartsch (S).
Odostomia (Chrysallida) virginalis Dall & Bartsch (S, W).

CYPRAEIDAE

Cypraea spadicea Swainson (50). One specimen.
Erato columbella Menke (W, 50). Eight specimens.
Trivia californiana (Gray) (54). Four specimens.
Trivia solandri (Gray & Sowerby) (W, 57). One specimen.

RANELLIDAE

Bursa calcipicta Dall (W). Judging from photographs of the type specimen, this species is very close to the following species.
Bursa californica (Hinds) (S, 50, 54, 57). Many specimens.

TRIPHORIDAE

Triphora sp. cf. *T. chamberlini* Baker (50). One specimen.
Triphora pedroana Bartsch (S, W).

CERITHIOPSIDAE

Cerithiopsis guadalupensis Strong (S).
Cerithiopsis oxys Bartsch (S, W).
Metaxia diadema Bartsch (S, W).
Seila montereyensis Bartsch (S, W).

CERITHIIDAE

Alabina diomede Bartsch (50). One specimen.
Alabina jordani Strong (S, W).
Bittium interfossum (Carpenter) (S).
Diastoma slevini Strong (S, 50, 54, 57). Common in dredgings.

CAECIDAE

Caecum californicum Dall (S).
Fartulum hemphilli Bartsch (S, W).

VERMETIDAE

Aletes squamigerus Carpenter (W).
Bivonia compacta Carpenter (57). Several on *Haliotis* shells.
Spiroglyphus lituellus (Morch) (W, 50, 57). Six on *Haliotis* shells.
Vermicularis eburnea (Reeve) (50). A few small specimens.

TURRITELLIDAE

Turritella orthosymmetra Berry (50, 54). Several specimens, mostly small.

LITTORINIDAE

Littorina planaxis Philippi (S, W, 50, 54, 57). Common.

FOSSARIDAE

Iselica fenestrata (Carpenter) (S).

LITIOPIDAE

Alaba jeannettae Bartsch (S).

BARLEEIIDAE

Barleeia californica Bartsch (S, W).

RISSOIDAE

Alvania aequisculpta Keep (S).
Alvania cosmia Bartsch (S, W).
Alvania oldroydae Bartsch (S, W).
Alvania purpurea Dall (S, W, 50). A few specimens in dredgings.
Amphithalamus inclusus Carpenter (S).
Amphithalamus tenuis Bartsch (S).
Nodulus kelseyi Bartsch (S).

RISSOINIDAE (as used by Dall)

Rissoina californica Bartsch (S, W).
Rissoina cleo Bartsch (S, W).
Rissoina guadalupensis Strong (S, W).
Rissoina lowei Strong (S, W, 57). Several specimens.
Rissoina willetti Strong (S, W).

RISSOELLIDAE

Rissoella bakeri Strong (S).

HIPPONICIDAE

Hipponix antiquatus (Linnaeus) (S, W, 50, 57). Two specimens.
Hipponix tumens Carpenter (S, W, 50, 57). Three specimens.

CALYPTRAEIDAE

Crepidula (Crepipatella) lingulata Gould (S, W, 50, 54, 57). Common on *Astraea undosa* Wood.
Crepidula perforans Valenciennes (57). One specimen.

VITRINELLIDAE

Macromphalina occidentalis Bartsch (50). One specimen.

NATICIDAE

Lamellaria stearnsi orbiculata Dall (57). One specimen.

ACMAEIDAE

Acmaea digitalis Eschscholtz (S, W, 50, 54, 57). Several specimens.
Acmaea limatula Carpenter (W, 50, 57). A few specimens.
Acmaea mesoleuca var. *vespertina Reeve* (57). A few specimens.
Acmaea paleacea Gould (S, W).
Acmaea pelta Eschscholtz (S, W).
Acmaea scabra (Gould) (50). Several specimens.
Lottia gigantea Gray (S, W, 50, 54, 57). Many specimens.

PHASIANELLIDAE

Tricolia pulloides (Carpenter) (S, W, 50).
Tricolia (Eulithidium) rubrilineata (Strong) (S, W).

TURBINIDAE

Astraea guadalupeana Berry (50). One specimen, with *A. inequalis*.
Astraea inequalis (Martyn) [= *A. gibberosa* (Dillwyn)] (57). The two specimens are close to the original figure of *Trochus inequalis* (Martyn 1784, pl. 31), and they match the original figures of *A. diadematа* (Valenciennes 1846, pl. 3, figs. 2-2b).
Astraea lithophora (Dall) (W).
Astraea sp. cf. *A. petrothauma* Berry (50). One specimen.
Astraea undosa (Wood) (S, 50, 54, 57). Many specimens; apparently more variable than on the mainland.
Homolopoma carpenteri (Pilsbry) (W, 57). A few specimens.
Homolopoma paucicostatum (Dall) (S, W).
Homolopoma luridum (Dall) (55). Two specimens.

Liotiidae

Liotia acuticostata Carpenter (S, W).
Liotia californica Dall (S, 50). Five specimens.
Liotia fenestrata Carpenter (S).
Liotia heimi Strong & Hertlein (50, 57). Several specimens.

Trochidae

Calliostoma splendens Carpenter (S, 50, 57). Two specimens.
Calliostoma sp. (W). An unidentified species also in 1957.
Margarites acuticostata Carpenter (W, 50, 54, 57). Common in dredgings.
Margarites parcipicta (Carpenter) (S, W).
Norrisia norrisii (Sowerby) (S, W, 50, 54, 57). Many specimens.
Tegula gallina (Forbes) (S, W).
Tegula gallina multifilosa (Stearns) (50, 57). Several specimens.
Tegula regina (Stearns) (S, 50, 54, 57). Several specimens.

Vitrinellidae

Circulus rossellinus Dall (S).
Teinostoma invallatum (Carpenter) (S, W).
Teinostoma supravallatum (Carpenter) (S, W).

Haliotidae

Haliotis californiensis Swainson (S, 54, 57). Many specimens.
Haliotis corrugata Gray (S, 55). Only four or five specimens.
Haliotis cracherodii Leach (S, W).
Haliotis sp. cf. *H. fulgens* Philippi (S, 54, 57). Not typical of *H. fulgens;* may be a new species.

Fissurellidae

Fissurella volcano Reeve (W, 50, 54). Only a few specimens.
Megathura crenulata (Sowerby) (50, 54). Three specimens; evidently not common.

Pelecypoda

Arcidae

Arca bailyi (Bartsch) (S).

Glycymeridae

Glycymeris guadalupensis Strong (S, W, 50, 54, 57). Common in dredgings.

PHILOBRYIDAE

Philobrya setosa (Carpenter) (S, W).

MYTILIDAE

Crenella columbiana Dall (57). One specimen.
Crenella divaricata (d'Orbigny) (S, W).
Crenella megas Dall (50). Fifteen valves.
Lithophaga plumula (Hanley) (54). One specimen.
Modiolus pallidulus Dall (50). Two specimens.

PECTINIDAE

Hinnites gigantea (Gray) (W).
Pecten diegensis Dall (50, 54). Several valves.
Pecten lowei Hertlein (50). One valve.
Pecten pernomus Hertlein (50, 54, 57). Many good pairs.

LIMIDAE

Lima subauriculata (Montague) (50, 54). Many valves.

THRACIIDAE

Thracia diegensis Dall (W).
Thracia squamosa Carpenter (50, 54, 57). Many small valves.

LYONSIIDAE

Lyonsia californica nesiotes Dall (50, 54, 57). Several live specimens.

CUSPIDARIIDAE

Cuspidaria pectinata (Carpenter) (50). Two valves.
Leiomya scaber (Carpenter) (50, 54). Three pairs and several valves.

ASTARTIDAE

Bernardina bakeri Dall (W).

CARDITIDAE

Glans carpenteri (Lamy) (W).
Milneria kelseyi Dall (S).
Milneria minima (Dall) (W).

CHAMIDAE

Chama buddiana C. B. Adams (50). Two upper valves.
Chama pellucida Browerip (S, W).

THYASIRIDAE

Thyasira barbarensis (Dall) (54). One valve.

Ungulinidae

Diplodonta subquadrata Carpenter (50). Eight valves.

Lucinidae

Lucina approximata (Dall) (50, 54). Six specimens plus some valves.
Lucina californica Conrad (S, W, 50, 54). A few valves.

Leptonidae

Kellia laperousii Deshayes (W, 50). One valve.

Cardiidae

Cardium biangulatum Broderip & Sowerby (54). Several pairs and valves.
Protocardia centifilosa (Carpenter) (50). Two valves.

Veneridae

Antigona fordi Yates (W, 54). Several pairs and valves.
Psephidea cymata Dall (S, W, 50, 54). Several pairs and valves.
Psephidea salmonea (Carpenter) (54). Three pairs and nine valves.
Transenella puella (Carpenter) (S, W, 50, 54, 57). Many live specimens and valves.

Tellinidae

Tellina pacifica Dall (W, 54, 57). Two pairs.

Semelidae

Semele incongrua Carpenter (54). One specimen.

Corbulidae

Grippina californica Dall (S).

Scaphopoda

Dentaliidae

Cadulus fusiformis Pilsbry & Sharp (S).
Dentalium berryi Smith & Gordon (50). One specimen.
Dentalium splendidulum Sowerby (50). One specimen in dredgings.
Siphonodentalium quadrifissatum Pilsbry & Sharp (S, W, 50, 57). Many specimens.

Polyplacophora

Lepidopleuridae

Lepidopleurus rugatus Pilsbry (57). One specimen.

Lepidochitonidae

Lepidochitona sp. (55). One very small specimen.
Nuttallina californica Reeve (57). Three specimens.

ISCHNOCHITONIDAE

Ischnochiton biarcuatus Dall (57). One specimen.
Ischnochiton mertensi (Middendorff) (57). Two specimens.

ACANTHOCHITONIDAE

Acanthochitona arragonites Carpenter (55). Two specimens.

PTEROPODA

CAVOLINIDAE

Cavolina inflexa (Lesueur) (50). Seven specimens.
Cavolina occidentalis Dall (50). One specimen.
Clio pyramidata Rang (50). Four fragments.
Cuvierina columella Rang (50). One specimen.

BRACHIOPODA

TEREBRATULIDAE

Terebratulina unguicula Carpenter (50). One valve.

TEREBRATELLIDAE

Platidia sp. cf. *P. anomioides radiata* Dall (57). Three specimens and five valves.

A NEW SPECIES OF GASTROPOD

Ocenebra seftoni sp. nov.

Shell small, white with a light tan-colored band on the shoulder and another below the periphery and with a few darker spots on the spiral cords and between the axial ribs on the base. Nuclear whorls 1½, squarish, a prominent keel at the top of the first whorl and a second keel developing below it on the last half of the nuclear. Later whorls 5, slopingly shouldered and distinctly angled at the periphery. Two spiral cords on the first whorl, increasing to 4 on the penultimate and to 9 on the body whorl. Axial ribs 9, rather strong, reaching from suture to suture and down over the base. Whole surface with fine axial lamellae, which are strongest where the cords pass over the axial ribs. Aperture oval, the outer lip thickened, especially where it joins the previous whorl; three denticles within. Callus rather heavy on the body whorl and on the slightly twisted columella. Siphonal canal about half as long as the aperture and well covered, the small umbilical chink nearly covered by the end of the columellar callus. Measurements of the holotype: height 12 mm.; diameter 6.2 mm.; height of the aperture 3.4 mm. Color description taken from one of the paratypes, which is brighter colored than the type.

The holotype is number 12955 in the conchological collection of the San Diego Natural History Museum. It was dredged in about 40 fathoms by Dr. Carl L. Hubbs and party, February 2, 1950, at Melpomene Cove, Guadalupe Island, Baja California, Mexico. Paratypes are at the California Academy of Sciences and at the Museum of Comparative Zoology, Harvard University. The species is named for Mr. Joseph Sefton, then owner of the Research Ship *Orca*, from which the type was collected.

The angular nuclear whorls indicate that the new species is closely related to *Ocenebra crispatissima* Berry, from Catalina Island, and to members of the *O. barbarensis* group. It is especially similar to *O. crispatissima* but has fewer spiral chords on the body whorl and a shorter siphonal canal.

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A NEW MOLLUSK FROM SAN FELIPE, BAJA CALIFORNIA

BY

E. P. CHACE

As it has become easier to collect in the northern part of the Gulf of California, molluscan material in collections has increased. This additional material has shown the intergradation of some forms originally described from scanty material as distinct. On the other hand, however, it has emphasized the distinctness of some forms that conservative students previously were unwilling to name. Among these latter forms is the *Nassarius* described below, of which previously only one specimen was known.

Nassarius howardae sp. nov.

Shell of medium size for the genus, white, the thin periostracum light tan near the aperture but darker above, high spired, the apex acute, the whorls fairly convex, the suture impressed well below periphery. Nuclear whorls 2½, smooth, white. Post-nuclear whorls 6. Axial ribs on early whorls 8, rounded, increasing to 25 on penultimate whorl and more on body whorl but becoming much weaker on base so that spirals are almost smooth. Spiral cords on early whorls 3, fairly strong, straplike, separated by channels about as wide, increasing to 7 or 8 on penultimate whorl and more on body whorl, forming low nodes where they pass over axial ribs. Aperture less than half length of shell; outer lip with varixlike thickening and 7 or 8 small elongate denticles within; inner lip with very thin callus on body whorl; columella nearly straight, with distinct channel just above its termination. Canal open, moderately deep. Some specimens with a second varix slightly more than ½ whorl back from aperture. Measurements of holotype: height 28 mm.; diameter 13½ mm.; height of aperture 11 mm.

The holotype is number 12954 in the conchological collection of the San Diego Natural History Museum. It was collected in December 1956 by Mrs. E. P. Chace and Mrs. Faye Howard at Almejas Beach, about 5 miles north of San Felipe, Baja California, Mexico. Paratypes are in the collections of Dr. S. Stillman Berry (Redlands, California), the California Academy of Sciences, the Museum of Comparative Zoology at Harvard University, and the Philadelphia Academy of Natural Sciences. Another specimen of this species, number 21879 in the collection of the San Diego Natural History Museum, was collected at San Felipe about 1935 by Mr. J. M. Snyder.

Nassarius howardae somewhat resembles *N. perpinguis* Hinds, but the shell is heavier and more porcellaneous and the spirals are broader. *Nassarius rhinetes* Berry differs in having only 5 spirals on the penultimate whorl, and its sculpture is much more open.

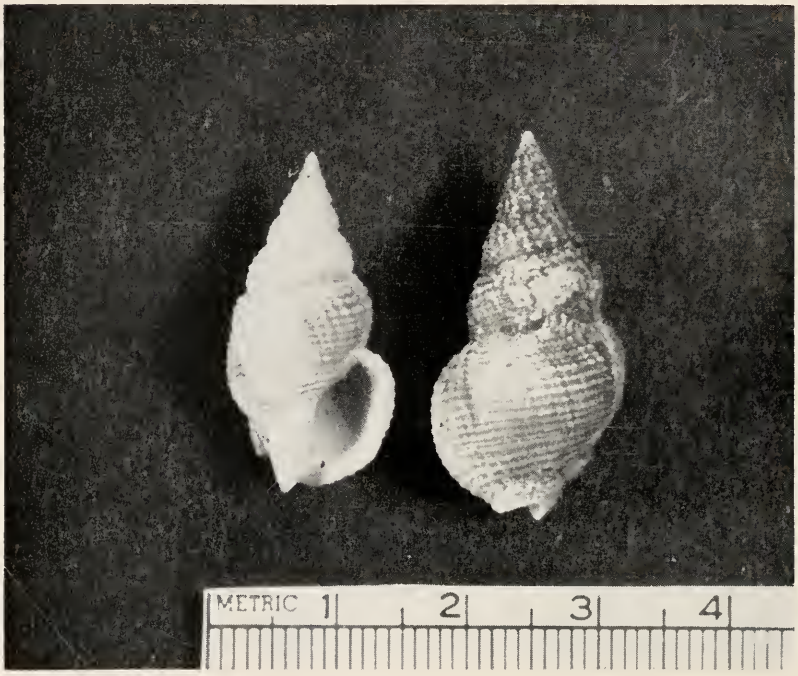

Fig. 1. *Nassarius howardae* sp. nov. Holotype (right) and paratype.

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PLEISTOCENE MOLLUSKS FROM TECOLOTE CREEK, SAN DIEGO, CALIFORNIA

BY

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INTRODUCTION

This paper records an ecologically significant assemblage of late-Pleistocene invertebrates from a marine terrace deposit in Tecolote Creek, San Diego County, California. Although the occurrence of fossils of this age has long been known in the San Diego area, the assemblage from this locality has not previously been described. Several locally extinct southern species of mollusks are recorded here for the first time in the Pleistocene fauna of this region.

We are indebted to George P. Kanakoff of the Los Angeles County Museum for calling our attention to this exposure and for permitting us to list the species which he collected from it. James R. Emerson kindly assisted in collecting. Dr. Leo G. Hertlein of the California Academy of Sciences collaborated in the identification of some of the fossils.

The collection is deposited in the San Diego Natural History Museum.

Locality Description

The fossils occur in a bluff about 20 feet in elevation bordering Linda Vista Mesa along the southeast side of the mouth of Tecolote Creek, on the north side of Mission Valley (see figs. 1, 2). The locality is about one-fifth of a mile northeast of Morena Boulevard along a private road to a Hazard Construction Company quarry.

The terrace platform angularly truncates fine-grained bluish-gray sand of the San Diego formation (mid-Pliocene). The terrace deposits are composed of a basal conglomerate, the fossiliferous sand, and a non-fossiliferous cover of sand and soil. The fossiliferous sediment is a poorly sorted, coarse, and well consolidated sand, which weathers dark brown. This sandstone locally overlies the conglomerate of pebbles and small boulders or, in the absence of the conglomerate, lies directly on the unevenly eroded surface of the Pliocene sediments. The contact is only a few feet above the adjacent valley floor (fig. 3).

Fragments of fossils occur locally in the marine sediments, but complete specimens are largely confined to thin beds at intervals above the level of the conglomerate. Oysters, however, are found attached to boulders and pebbles in the upper part of the conglomerate. Paired valves of *Tagelus californianus* commonly appear in the upper part of the sandstone, and occasional paired valves of *Chione gnidia* and *Chione californiensis* are present in the basal part of this bed.

The apparently non-fossiliferous terrace cover is 1 to 10 feet thick and weathers reddish-brown. It is presumably alluvial in origin and therefore is late Pleistocene (?) and Recent in age.

Composition and Inferred Significance of the Fauna

The writers collected 61 species of mollusks from three stations in the bluff. Nine additional molluscan species were obtained from the exposure by Mr. George P. Kanakoff. The collected fauna therefore totals 70 species of mollusks, including 34 pelecypods, 1 chiton, and 35 gastropods. The fauna is enumerated in table 1. Names of species reported by Mr. Kanakoff but not seen by the writers are enclosed in brackets.

The composition of the fauna suggests a semi-protected shallow-water assemblage of a bay-lagoon environment. The large number of rock and sand inhabitants and rocky rubble dwellers require a hard substrate, but the presence of some tidal-flat inhabitants, such as *Melampus, Cerithidea,* and *Nassarius tegula,* indicates adjacent mudflats. Such substrates exist in San Diego and Mission Bays at the present time.

The habitat requirements are corroborated by the composition and sequence of the terrace sediments. The basal conglomerate is overlain by local beds of coarse sand containing fragmental and minute shells with occasional complete larger shells. This in turn is overlain by thin zones containing paired specimens of the bay razor clam, *Tagelus californianus,* in the finer grained sand near the top of the deposit.

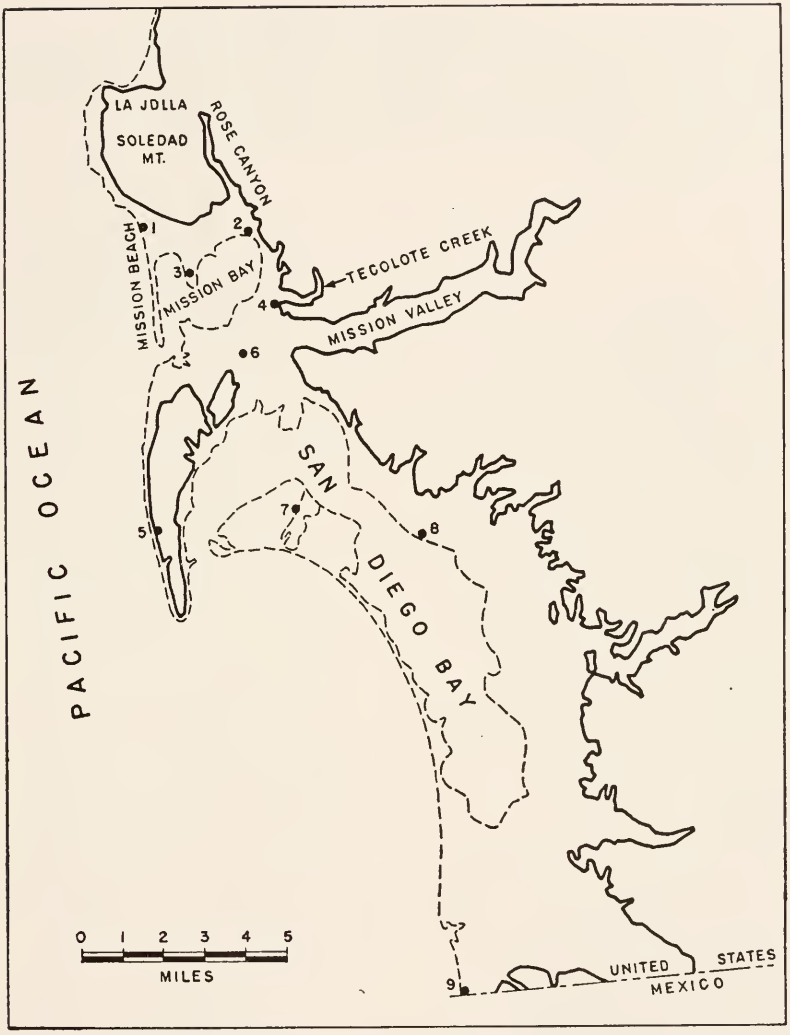

FIG. 1. The San Diego area, showing late Pleistocene fossiliferous deposits.

The broken line shows the present coastline; the solid line approximately delineates the present 100-foot contour (modified after Stephens 1929). Numbers indicate the late Pleistocene fossiliferous localities mentioned in the text: 1. Pacific Beach (Arnold 1903), 2. Railroad Cut (Stephens 1929), 3. Bay Point [Crown Point] (Stephens 1929), 4. Tecolote Creek, 5. West side of Point Loma (Webb 1937), 6. East side of Point Loma (Stephens 1929), 7. Spanish Bight (Hertlein and Grant 1944), 8. Indian Point [foot of 26th Street] (Arnold 1903), 9. Border locality (Emerson and Addicott 1953).

TABLE 1. Mollusks from Tecolote Creek

Names in brackets are for species reported by George P. Kanakoff but not seen by the writers. Occurrence in other Late Pleistocene deposits of the San Diego area is shown, based on the following reports: (1) Pacific Beach, Arnold (1903); (2) Point Loma, Webb (1937); (3) Spanish Bight, Hertlein and Grant (1944); (4) Indian Point, Arnold (1903); and (5) Border locality, Emerson and Addicott (1953).

	Pacific Beach	Point Loma	Spanish Bight	Indian Point	Border locality
PELECYPODA					
Anomia peruviana d'Orbigny	x	..	x	..	x
Cardium cf. *C. biangulatum* Broderip and Sowerby (juvenile)	..	..	..	..	..
[*Cardium procerum* (Sowerby)]	..	..	x	x	..
[*Cardium quadragenarium* (Conrad)]	x	..	x	x	..
Chione californiensis (Broderip)	..	x	..	x	x
[*Chione cortezi* (Carpenter)]	..	..	..	..	..
Chione gnidia (Broderip and Sowerby)	..	..	x	..	..
Corbula luteola Carpenter	..	..	x	x	x
[*Crassinella branneri* (Arnold)]	..	..	x	x	x
[*Crassinella nuculiformis* Berry]	..	..	..	..	..
Cryptomya californica (Conrad)	..	..	x	x	x
Diplodonta sericata (Reeve)	..	..	x	x	..
Donax californica Conrad	..	..	x	..	..
[*Glycymeris subobsoleta* (Carpenter)]	x	..	?	..	?
Lucina approximata (Dall)	x	..	x	x	..
Lucina nuttalli Conrad	x	..	x	x	x
Macoma acolasta Dall	..	..	..	..	..
Macoma pacis Pilsbry and Lowe	..	..	..	..	..
Macoma yoldiformis Carpenter	..	..	x	..	..
Mactra cf. *M. californica* Conrad	..	..	x	x	x
Nucula exigua Sowerby	..	..	?	..	..
Ostrea angelica Rochebrune	..	..	?	..	..
Ostrea cf. *O. lurida* Carpenter	x	x	?	x	..
Pecten circularis Sowerby	..	?	..	?	?
Pecten latiauritus Conrad	..	x	x	x	?
[*Petricola parallela* Pilsbry and Lowe]	..	..	..	..	..
Protothaca staminea (Conrad)	..	x	x	x	x
Semele quentinensis Dall	..	..	..	..	..
Septifer bifurcatus (Conrad)	x	x	..	..	..
Siliqua lucida (Conrad)	..	..	x	x	..
Tagelus californianus (Conrad)	..	..	x	x	..
Tellina cf. *T. idae* Dall (frag.)	..	..	..	..	..
Tellina meropsis Dall	..	?	x	..	x
[*Zirfaea pilsbryi* Lowe]	..	..	..	..	x

TABLE 1—Continued

	Pacific Beach	Point Loma	Spanish Bight	Indian Point	Border locality
AMPHINEURA					
Lepidochitona keepiana Berry	..	..	..	..	..
GASTROPODA					
Acmaea insessa (Hinds)	..	x	x	..	..
Acmaea limatula Carpenter	..	?	..	..	..
Acteocina cf. *A. culcitella* (Gould)	..	..	x	x	..
Alabina cf. *A. io* Bartsch	?	..	?	?	..
Alabina tenuisculpta (Carpenter)	..	..	..	..	..
Anachis coronata hannana Hertlein and Strong	..	..	..	..	..
Bittium interfossa (Carpenter)	..	..	..	..	..
Bulla gouldiana Pilsbry	..	..	x	..	..
Caecum californicum Dall	..	..	x	..	..
Cerithidea californica (Haldeman)	x	x	x	x	..
Cerithiopsis carpenteri Bartsch	..	..	..	..	..
Crucibulum spinosum (Sowerby)	x	..	x	x	..
Cylichnella attonsa (Carpenter)	..	..	..	..	..
Diodora inaequalis (Sowerby)	..	x	..	..	x
Eupleura muriciformis Broderip	..	..	x	x	..
Littorina scutulata Gould	..	x	x	..	x
Lucapinella callomarginata (Dall)	..	..	..	..	..
"Mangelia" barbarensis Oldroyd	x	..	x	..	..
Melampus olivaceus Carpenter	..	..	x	x	..
Micranellum crebricinctum (Carpenter)	..	..	x	..	..
Morula lugubris (C. B. Adams)	..	..	..	..	..
Nassarius tegula (Reeve)	..	..	x	x	..
Ocenebra cf. *O. barbarensis* (Gabb)	..	..	..	..	..
Ocenebra foveolata (Hinds)	..	x	..	..	..
Odostomia fetella Dall and Bartsch	..	..	x	..	..
Olivella baetica Carpenter	..	..	x	..	..
Pedipes liratus Binney	..	..	..	..	..
Pedipes unisulcatus Cooper	..	..	..	..	..
[*"Phyllonotus" radix nigritus* (Philippi)]	..	..	..	..	..
Pyramidella cf. *P. adamsi* Carpenter	..	..	..	..	..
Retusa harpa (Dall)	..	..	..	..	..
Syncera translucens (Carpenter)	..	..	x	..	..
Tegula ligulata (Menke)	..	..	x	..	..
Triphora pedroana Bartsch	..	..	..	..	..
Turbonilla aepynota Dall and Bartsch	..	..	..	..	..

With the exception of *Macoma acolasta* (Dall 1921a), the assemblage is composed entirely of extant species. The fauna contains, however, a significant warm-water element comprising species which now are locally extinct (see table 2) or near the northern endpoint of their range (see table 3). The presence of this "tropical" element required water temperatures warmer than now exist in the San Diego area and thus suggests that a northern shift of marine isotherms had occurred prior to the deposition of these terrace deposits. Similar warm-water faunas are known from late Pleistocene terrace deposits of the Los Angeles basin (Woodring *et al.* 1946).

Constituents of the Tecolote Creek fauna known to occur in other assemblages of late Pleistocene age in the San Diego area are shown in table 1. Of particular ecologic significance are *Eupleura muriciformis, Cardium procerum, Crassinella branneri, Diplodonta sericata,* and *Chione gnidia,* which are warm-water indicators. They are known from Tecolote Creek and Spanish Bight, and the first four occur at Indian Point. None of them, however, has been found at Pacific Beach, and only one, *Crassinella branneri,* is recorded from the Border locality. Also, Stephens (1929) listed *Chione gnidia* and *Diplodonta sericata* from the Railroad Cut.

In the San Diego region, warm-water elements are thus known from the lowest exposed terrace deposits at Spanish Bight (Hertlein and Grant 1944), at Railroad Cut (Stephens 1929), at Indian Point (Arnold 1903), and on the protected side of Point Loma (Stephens 1929). Mixed associations of warm-water and cool-water indicators are recorded from the Border locality. Cold-water assemblages are known from the exposed western side of Point Loma (Webb 1937; Berry 1922) and from Pacific Beach (Arnold 1903).

When the distribution of the faunas is viewed in terms of Pleistocene topography, a close correlation is evident between the inferred hydroclimate of the embayment and the composition of the fauna (fig. 1). Associations dominated by warm-water elements lived in semi-protected back-bay habitats; associations dominated by cool-water elements lived in open-coast habitats; and mixed associations lived in intermediate habitats.

This distributional pattern is apparently explained by the presence of near-shore highlands which sheltered parts of the embayment from northwest weather. Soledad Mountain protected back-bay sites in the Mission Bay and Mission Valley areas, including warm-water assemblages at the Railroad Cut and Tecolote Creek. Pleistocene Point Loma island protected the Spanish Bight and especially the back-bay areas, such as Indian Point. Exposed localities, Pacific Beach and the windward side of Point Loma island, supported predominantly cool-water assemblages. The partially protected Border locality, on the other hand, apparently supported a mixed assemblage with cool-water elements predominating. Although some mixing of faunal elements may have resulted from transportation by currents and from redeposition of sediments, the totality of evidence suggests that the faunal composition reflects local habitat conditions (Emerson 1956).

TABLE 2. Locally extinct "southern" mollusks in the Tecolote Creek fauna

	Northern End Point of Present Range
GASTROPODA	
Anachis coronata hannana	Scammon Lagoon, Baja California (Hertlein and Strong 1951)
Eupleura muriciformis	Cedros Island, Baja California (Hertlein and Strong 1955)
"Phyllonotus" radix nigritus	Scammon Lagoon, Baja California (Jordan 1924)
PELECYPODA	
Cardium procerum	Lagoon Head, Baja California (Hertlein and Strong 1947)
Chione cortezi	Magdalena Bay, Baja California (Keen 1958)
Chione gnidia	Cedros Island, Baja California (Hertlein and Strong 1948)
Crassinella branneri	Scammon Lagoon, Baja California (Woodring *et al.* 1946)
Crassinella nuculiformis	Cape San Lucas, Baja California (Woodring *et al.* 1946)*
Macoma acolasta	Extinct [Pleistocene of San Quentín Bay, Baja California (Dall 1921a)]
Macoma pacis	Gulf of California to Costa Rica (Hertlein and Strong 1949)
Nucula exigua	Turtle Bay, Baja California (Hertlein and Strong 1940)
Ostrea angelica	Punta Peñasco, Sonora (E. P. Chace, collector)
Petricola parallela	Scammon Lagoon, Baja California (Hertlein and Strong 1948)
Pecten circularis circularis	Cedros Island, Baja California (Hertlein and Strong 1946)

*The living specimens have been referred to *Crassinella varians* (Carpenter) by authors, but the identity of Carpenter's species is questionable (Woodring *et al.* 1946).

TABLE 3. Certain locally extant "southern" species in the Tecolote Creek fauna

	Present Range
GASTROPODA	
Morula lugubris	Off Catalina Island and Redondo Beach, California (Burch 1940) to Panama (Adams 1852)
PELECYPODA	
Cardium biangulatum	Off Catalina Island and Redondo Beach, California (Burch 1944b) to Guayaquil, Ecuador (Hertlein and Strong 1947)
Diplodonta sericata	? Monterey Bay, California (Smith and Gordon 1948; Burch 1944a); San Ignacio Lagoon, Baja California, to Guayaquil, Ecuador (Hertlein and Strong 1947)
Semele quentinensis	Point Mugu, California, to Costa Rica (Hertlein and Strong 1949)
Tellina meropsis	? Off Monterey, California (Burch 1944a); San Diego, California (Dall 1921b) to Panama (Burch 1944b)

Several prominent terraces have been noted in this region. Ellis (1919) mapped the major terraces in coastal southwestern San Diego County and described five terraces in the San Diego Bay area, namely: Tijuana terrace at an elevation of 20 to 50 feet; Nestor terrace at 25 to 100 feet; Chula Vista terrace at 100 to 130 feet; Avondale terrace at 200 to 250 feet; and Otay terrace at 430 to 525 feet. All but the lowest, the Tijuana terrace, were considered to be of marine origin. In addition to these, Hertlein and Grant (1944) mentioned the presence of other, less prominent, poorly developed and preserved terraces in the area. Hanna (1926) proposed the name La Jolla terrace for the lowest prominent terrace exposed in the La Jolla region and continuing southward to Pacific Beach and along the west side of Point Loma (Webb 1937). Gale (1931) believed the La Jolla terrace to be a northern extension of the Nestor terrace. Carter (1957) considered the lowest marine terrace referable to the Tijuana terrace and recognized remnants of it in several areas of coastal San Diego County. Carter, however, did not demonstrate the presence of fossiliferous deposits on the platform of his Tijuana terrace.

Owing to the remnantal preservation of the lowest exposed major marine terraces of the area, it is not possible at the present time to establish precise correlations between the various isolated outcrops. These deposits in the San Diego area have been designated in part the Bay Point formation, and correlated with the Palos Verdes formation of the Los Angeles region (Hertlein and Grant 1939).

On the basis of the available faunistic and physiographic evidence, it is assumed that the fossiliferous sediments described from Tecolote Creek were deposited on the Nestor terrace platform and are referable to the Bay Point formation. Carbon-14 dates are known for similar terrace features elsewhere in California. Deposits from the lowest exposed terrace of the Palos Verdes Hills of San Pedro (Kulp *et al.* 1952), Santa Rosa Island (Orr 1956), and Santa Cruz (Bradley 1956) all showed ages greater than 30,000 years. The modern composition of the faunas, the limited available carbon-14 data, and the known physiographic relationships of the terrace deposits, suggest the age of these faunas to be later than early Pleistocene and older than Wisconsin time (Addicott and Emerson 1959).

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Fig. 2. Bluff on the southeast side of Tecolote Creek.

Fossils were collected in the Pleistocene sands exposed above the talus slope.

Fig. 3. Bluff on the southeast side of Tecolote Creek.

Here may be seen the contact of the basal Pliocene sand and the terrace sediments composed of sand, conglomerate, and non-marine cover.

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TRANSACTIONS

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TYPE LOCALITIES OF VASCULAR PLANTS IN SAN DIEGO COUNTY, CALIFORNIA

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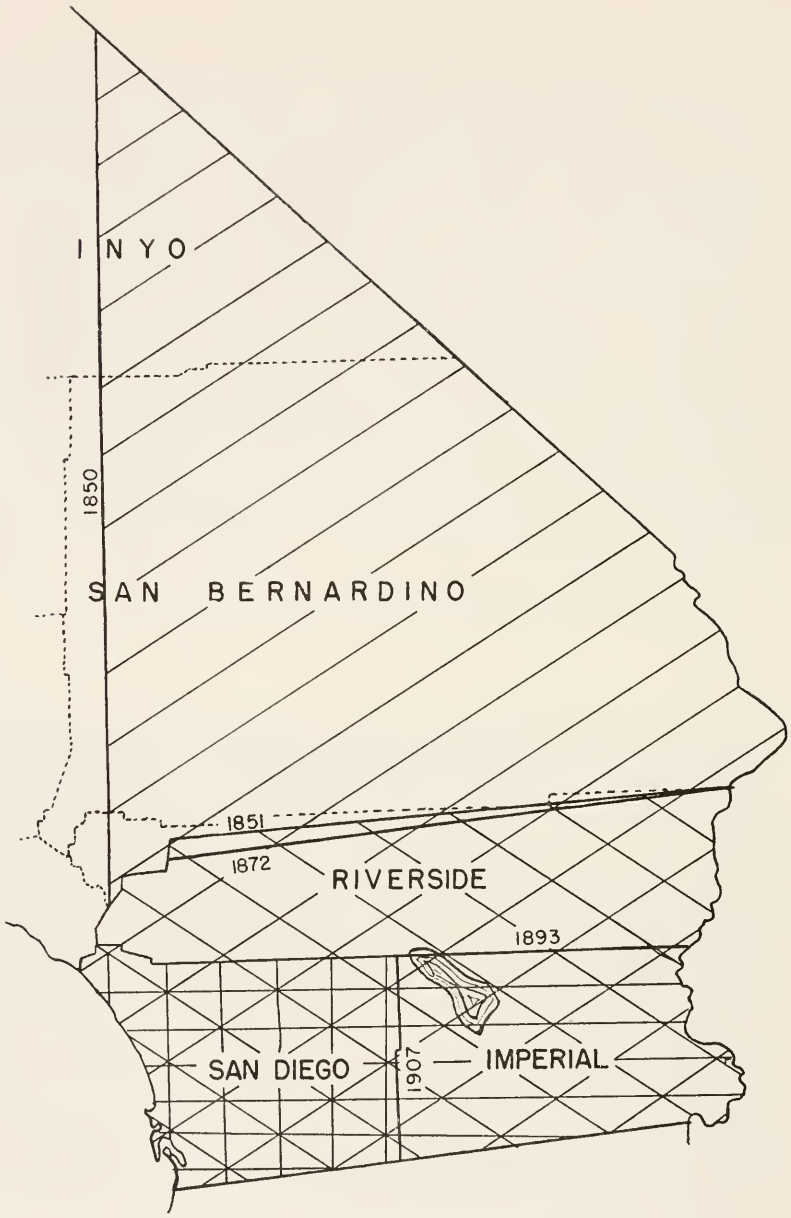

FIG. 1 Past and present boundaries of San Diego County.

The area of San Diego County has been reduced in the years shown, with the formation of Inyo, San Bernardino, Riverside, and Imperial Counties. (Redrawn by Wesley Farmer from a map originally prepared by Bertram B. Moore.)

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INTRODUCTION

When a new species of plant is discovered and named, one specimen of it is designated as the *type specimen* or *type*. Later interpretation of the name must if possible be based on this specimen. The place where the type specimen is collected is known as the *type locality*. This locality is important because any specimen of the species collected there has a certain authenticity in the interpretation of the species. If the type specimen is lost or unavailable, or if it is incomplete or abnormal, such another specimen may be especially valuable.

This paper lists type localities of vascular plants within the present boundaries of San Diego County. So far as possible, all proposed species and varieties from this area are included, regardless of whether they are considered valid. For want of definite data, however, it is sometimes difficult to know whether a type locality is within the County. In early times, lack of accurate maps and lack of place names often made precise location difficult even if the need for it was felt. In doubtful cases, the distribution of the species and the itinerary of the collector, so far as known, have been taken into account.

As shown in fig. 1, San Diego County has several times been reduced in size. As a result, some type localities originally in San Diego County now are in Riverside County or Imperial County. Yet in the botanical literature, some of these may still be given as in San Diego County.

Many plants of San Diego County were named before the type concept was established. If the author cited only one collection, this automatically is the type; if he cited more than one, some later student is permitted to select one of these as the type. The present paper does not select types; but it records such selections as are known to have been made, even though the basis for selection may be questionable. When no selection is known to have been made, it is possible only to record the several localities originally cited.

SYSTEMATIC LIST OF PLANTS

POLYPODIACEAE

Asplenium vespertinum Maxon, Bull. Torrey Club 27: 197. 1900.

"San Miguel Mountain", *Kimball*, about February 1, 1900.

Cheilanthes Clevelandii D. C. Eaton, Bull. Torrey Club 6: 33. 1875.

"Growing on a mountain about forty miles from San Diego, California, at an elevation of about 2,500 feet", *Cleveland*.

Notholaena californica D. C. Eaton, Bull. Torrey Club 10: 27. 1883.

"San Diego Co.", *Burbeck*, 1878. According to Tryon (1956, p. 73) this is the type, and the locality is Spring Valley.

Notholaena candida var. **accessita** Jepson, Man. Fl. Pl. Calif. 27. 1925.

"Upper Vallecito", *Jepson 8031*.

Notholaena Newberryi D. C. Eaton, Bull. Torrey Club 4: 12. 1873.

"San Diego", *Newberry*, November 8, 1851. Although another collection also was cited, this is the type according to Tryon (1956, p. 43).

Pityrogramma triangularis var. **viscosa** (D. C. Eaton) Weatherby. *Gymnogramme triangularis* var. *viscosa* D. C. Eaton, Ferns N. Am. 2: 16. 1880.

"San Diego", *Cleveland*.

OPHIOGLOSSACEAE

Ophioglossum californicum Prantl, Ber. Deuts. Bot. Ges. 1: 351. 1883.

"Californien." According to Clausen (1938, p. 160) the type was collected near San Diego by Cleveland in April 1882.

ISOETACEAE

Isoetes Orcuttii A. A. Eaton, Fern Bull. 8: 13. 1900.

"San Diego . . . low depressions on top of the mesas", *Orcutt*, June 7, 1884.

SELAGINELLACEAE

Selaginella cinerascens A. A. Eaton, Fern Bull. 7: 33. 1899.

"On bare ground, National City", *Kimball*.

PINACEAE

Cupressus Forbesii Jepson, Madroño 1: 75. 1922.

"Cedar Canyon, between El Nido and Dulzura", *Forbes*, December 30, 1907.

Cupressus Stephensonii C. B. Wolf, Aliso 1: 125. 1948.

"Upper limits of King Creek, a tributary to the South Fork of the San Diego River, Cuyamaca Mountains . . . at about 4,000 ft. elevation on a dry ridge near the creek", *Wolf 9467,* December 1, 1938.

Pinus cembroides var. **Parryana** (Engelmann) Voss.
Pinus Parryana Engelmann, Am. Jour. Sci. ser. 2. 34: 332. 1862.

"On the mountains east of San Diego", *Parry,* 1850.

Pinus Torreyana Parry, Bot. Mex. Bound. 210. 1859.

"Bluffs near the mouth of Soledad creek, 10 miles north of San Diego", *Parry.*

Pseudotsuga macrocarpa (Vasey) Mayr.
Abies macrocarpa Vasey, Gard. Month. Hort. 18:21. 1876.

"Mountains near San Felipe", *Newberry,* November 1857.

GNETACEAE

Ephedra californica S. Watson, Proc. Am. Acad. 14: 300. 1879.

"Promontory near San Diego and Jamul Valley", *Palmer 364 & 365,* 1875. According to Abrams (1923, p. 78) the type locality is Point Loma.

NAIADACEAE

Potamogeton pauciflorus var. **californicus** Morong, Bot. Gaz. 10: 254. 1885.

"San Diego County", *S. B. and W. F. Parish.* Many Parish collections labeled as from San Diego County are from what is now Riverside County.

GRAMINEAE

Agropyron Parishii var. **laeve** Scribner & Smith, U. S. Dep. Agr. Div. Agrost. Bull. 4: 28. 1897.

"Fowleys, Cuiamaca Mountains", *Palmer 414,* 1875.

Agrostis diegoensis Vasey, Bull. Torrey Club 13: 55. 1886.

"San Diego", *Orcutt 1058.* According to Orcutt (1908, col. 43) the locality is Chollas Valley, San Diego.

Agrostis Kennedyana Beetle, Bull. Torrey Club 72: 547. 1945.

"San Diego", *Grant 896,* April 1902.

Bromus grandis (Shear) Hitchcock.
Bromus Orcuttianus var. *grandis* Shear, U. S. Dep. Agr. Div. Agrost. Bull. 23: 43. 1900.

"La Maite, San Diego", *Orcutt 472.* According to Orcutt (1909, col. 521) the locality is La Monte, near El Cajon.

Bromus Orcuttianus Vasey, Bot. Gaz. 10: 223. 1885.

"Mountains near San Diego", *Orcutt,* 1884. According to Orcutt (1908, col. 45) the locality is Smith Mountain and the collector was H. C. Orcutt [father of C. R. Orcutt].

Calamagrostis densa Vasey, Bot. Gaz. 16: 147. 1891.

"Near Julian", *Orcutt.*

Calamagrostis koelerioides Vasey, Bot. Gaz. 16: 147. 1891.

"Near Julian", *Orcutt.*

Danthonia californica var. **unispicata** Thurber in S. Watson, Bot. Calif. 2: 294. 1880.

"From San Diego to San Francisco", *Bolander, Parry, Lemmon.*

Deschampsia gracilis Vasey, Bot. Gaz. 10: 224. 1885.

"Mesas about San Diego", *Orcutt.*

Elymus Orcuttianus Vasey, Bot. Gaz. 10: 258. 1885.

"Near San Diego", *Orcutt.*

Eragrostis Orcuttiana Vasey, Contr. U. S. Nat. Herb. 1: 269. 1893.

"San Diego", *Orcutt 1313,* 1885.

Koeleria nitida var. **californica** subvar. **transiens** Domin, Bibl. Bot. 65: 234. 1907.

"San Diego", *Brandegee,* 1903.

Koeleria nitida var. **californica** subvar. **vestita** Domin, Bibl. Bot. 65: 234. 1907.

"Cusamacca Mts.", *Palmer 405,* 1875.

Koeleria pseudocristata var. **californica** Domin, Magyar Bot. Lapok 3: 264. 1904.

"Hills, San Diego", *Pringle,* 1882.

Leptochloa imbricata Thurber in S. Watson, Bot. Calif. 2: 293. 1880.

"Larken's Station, San Diego County", *Palmer 404,* August 1875; also Fort Yuma and through the Gila Valley to the Rio Grande.

Phalaris intermedia var. **angustata** Beal, Grasses N. Am. 2: 182. 1896.

"California", *Pringle,* 1882. According to Hitchcock (1935, p. 925) the locality is San Diego.

Poa capillaris Scribner, U. S. Dep. Agr. Div. Agrost. Bull. 11: 51. 1898.

"Potrero", April 9, 1892. "Name of collector not given."

Poa Orcuttiana Vasey, West. Am. Sci. 3: 165. 1887.

"Near San Diego", *Orcutt 1070,* 1884; also Santa Barbara County. According to Hitchcock (1935, p. 944), the San Diego specimen is the type.

Sitanion minus J. G. Smith, U. S. Dep. Agr. Div. Agrost. Bull. 18: 12. 1899.

"Jacumba Hot Springs, near monument 233, altitude 900 m.", *Schoenefeldt 3277*, May 24, 1894.

Sporobolus altissimus Vasey, Proc. Calif. Acad. ser. 2. 2: 212. 1889.

"San Diego", *Palmer*, 1888.

Stipa coronata Thurber in S. Watson, Bot. Calif. 2:287. 1880.

"Hills near Julian City", *Bolander;* also near San Bernardino. Probably a duplicate type according to Hitchcock (1925, p. 226) is a specimen in the U. S. National Herbarium collected "in a canyon around springs on hillsides near Julian City, San Diego Co., Apr. 1872."

Stipa diegoensis Swallen, Jour. Wash. Acad. 30: 212. 1940.

"Along vernal stream in chaparral, Proctor Valley near Jamul", *Gander 5778*, May 23, 1938.

CYPERACEAE

Carex monticola Dewey in Torrey, Bot. Mex. Bound. 229. 1859.

"Mountains east of San Diego", *Parry*.

Carex praegracilis Boott, Bot. Gaz. 9: 87. 1884.

"San Diego", *Scott*, 1880.

Carex spissa Bailey, Proc. Am. Acad. 22: 70. 1886.

"San Diego Co.", *Pringle*, 1882; also San Juan Capistrano, Arizona, Baja California.

PALMAE

Washingtonia filifera (Linden) Wendland.
Pritchardia filifera Linden ex André, Ill. Hort. 24: 32, 105. 1877.

"Des bords du Colorado, dans l'Arizona", *Roezl*, 1869. According to Parish (1909b, p. 462) the seeds from which the original plants were grown probably were collected by Roezl from trees cultivated in San Diego.

LILIACEAE

Allium Bullardiae A. Davidson, Bull. So. Calif. Acad. 22: 72. 1923.

"Near San Julian, San Diego Co.", *Bullard*, April 1923 (*Davidson 3575*).

Allium praecox T. S. Brandegee, Zoe 5: 228. 1906.

"Common about San Diego, on northern slopes of cañons, especially near the coast." Brandegee mentioned several other localities, but according to Abrams (1923, p. 396) this is the type locality.

Allium tenellum A. Davidson, Bull. So. Calif. Acad. 21: 39. 1922.
"Julian", *Bullard,* May 1922 (*Davidson 3524*).

Bloomeria Clevelandii S. Watson, Proc. Am. Acad. 20: 376. 1885.
"Mesas near San Diego", *Cleveland,* 1874.

Bloomeria crocea (Torrey) Coville.
Allium croceum Torrey, Bot. Mex. Bound. 218. 1859.
"Summit of the mountains east of San Diego", *Parry.*

Brodiaea Orcuttii (Greene) Baker.
Hookera Orcuttii Greene, Bull. Calif. Acad. 2: 138. 1887.
"San Diego county, near the city of that name, and also thirty miles to the northward", *Orcutt,* 1884.

Calochortus concolor Purdy, Proc. Calif. Acad. ser. 3. 2: 135. 1901.
"Laguna, on the edge of the desert, San Diego County", *Cleveland.*

Calochortus Davidsonianus Abrams, Ill. Fl. Pac. States 1: 441. 1923.
"Grassy slopes between the Onofre Mountains and the sea", *Abrams 3275,* 1903.

Calochortus Dunnii Purdy, Proc. Calif. Acad. ser. 3. 2: 147. 1901.
"Near Julian", *Dunn.* Described from specimens cultivated by Purdy.

Calochortus Weedii Wood, Proc. Acad. Phila. 1868: 169. 1868.
"San Diego", *Weed.*

Chlorogalum parviflorum S. Watson, Proc. Am. Acad. 14: 243. 1879.
"Cajon Valley", *Cleveland,* 1877.

Hookera multipedunculata Abrams, Bull. Torrey Club 32: 537. 1905.
"In heavy soil near Cuyamaca Lake", *Abrams 3897,* June 25, 1903.

Lilium Fairchildii M. E. Jones, Contr. West. Bot. 16: 39. 1930.
From the garden of Mr. Rausch, Palomar Mountain, *Jones,* July 1929. The plants were originally collected locally in pine woods in deep shade. The species was named for Dr. J. H. Fairchild of Claremont.

Nolina interrata Gentry, Madroño 8: 181. 1946.
"Slope west of Dehesa School", *Gentry 7330,* August 5, 1945.

Yucca schidigera Roezl ex Ortgies, Gartenflora 20: 110. 1871.
Near San Diego, *Roezl,* 1869.

Yucca Whipplei Torrey, Bot. Mex. Bound. 222. 1859.
"On rocks near San Pasqual", *Schott.*

Zygadenus diegoensis A. Davidson, Bull. So. Calif. Acad. 23: 105. 1924.

"Palomar Mts.", *Fultz* (*Davidson 3592*). Described from specimens cultivated by R. Kessler.

AMARYLLIDACEAE

Agave consociata Trelease, Missouri Bot. Gard. Rep. 22: 53. 1912.

"San Felipe", *Parish 413,* June 1882.

Agave deserti Engelmann, Trans. Acad. St. Louis 3: 310. 1875.

"Eastern base of the Southern California mountains and in the adjoining deserts", *G. N. Hitchcock,* 1875; *Palmer,* 1875. According to Trelease (1912, p. 53) these specimens are from east of San Felipe.

Agave Shawii Engelmann, Trans. Acad. St. Louis 3: 314. 1875.

"On the arid hills which overlook the sandy strand of the Pacific in the southwest corner of California, where the boundary is marked by the initial monument", *Parry,* 1850; *Hitchcock and Parker,* 1875; *Palmer,* 1875.

ORCHIDACEAE

Piperia Cooperi (S. Watson) Rydberg.
Habenaria Cooperi S. Watson, Proc. Am. Acad. 12: 276. 1877.

"On clay hills near San Diego", *Cooper.*

Piperia leptopetala Rydberg, Bull. Torrey Club 28: 637. 1901.

"Mountains east of San Diego", *Parry,* 1850.

FAGACEAE

Quercus agrifolia var. **oxyadenia** (Torrey) J. T. Howell.
Q. oxyadenia Torrey, Sitgreaves Rep. 172. 1853.

"Santo Isabelle", *Woodhouse,* December 1851.

Quercus ×Ganderi C. B. Wolf, Proc. Calif. Acad. ser. 4. 25: 178. 1944.

"About 300 yards north of the entrance to the Volcan Indian School on California State Highway No. 79 between Santa Ysabel and Lake Henshaw, at 3100 feet elevation, in decomposed granite soil, near an occasional stream just west of the highway", *Wolf and Everett 9543,* October 20, 1939.

Quercus Palmeri Engelmann, Trans. Acad. St. Louis 3: 393. 1877.

"In the mountains 80 miles east of San Diego", *Palmer.* According to Abrams (1910, p. 346) it was first discovered "about five miles west of Jacumba Hot Spring."

POLYGONACEAE

Chorizanthe discolor Nuttall, Jour. Acad. Phila. ser. 2. 1:167. 1848.

"St. Diego", *Nuttall,* 1836. Although no collector was given for this species, the next-listed species was collected "With the preceding . . . (Nuttall)".

Chorizanthe fimbriata Nuttall, Jour. Acad. Phila. ser. 2. 1:168. 1848.

"St. Diego", *Nuttall,* 1836.

Chorizanthe fimbriata var. **laciniata** (Torrey) Jepson.
C. laciniata Torrey, Pacif. Railr. Rep. 7 (3): 19. 1857.

"San Felipe", *Antisell,* May 1855.

Chorizanthe leptotheca Goodman, Ann. Missouri Bot. Gard. 21: 61. 1934.

"Dry hills between Ramona and Ballena", *Abrams 3777,* June 19, 1903.

Chorizanthe Orcuttiana Parry, Proc. Davenp. Acad. 4: 54. 1884.

"Exposed sandy soil on Pt. Loma", *Orcutt,* March 1884.

Chorizanthe procumbens Nuttall, Jour. Acad. Phila. ser. 2. 1: 167. 1848.

"St. Diego", *Nuttall,* 1836.

Chorizanthe procumbens var. **albiflora** Goodman, Ann. Missouri Bot. Gard. 21: 87. 1934.

"Dry slope 2 miles east of Pala", *Munz 10372,* April 30, 1926.

Chorizanthe Thurberi (A. Gray) S. Watson.
Centrostegia Thurberi A. Gray ex Bentham in DeCandolle, Prod. 14: 27. 1857.

"In collibus arenosis ad San Felipe", *Thurber,* May 1852.

Chorizanthe uncinata Nuttall, Jour. Acad. Phila. ser. 2. 1: 167. 1848.

"St. Diego", *Nuttall,* 1836.

Eriogonum cernuum subsp. **viscosum** Stokes, Gen. Eriog. 42. 1936.

"Near road, Campo to Buckman Springs", *Stokes 3102.*

Eriogonum fasciculatum var. **maritimum** Parish, Muhlenbergia 3: 59. 1907.

"Oceanside", *Parish 4445,* June 1897.

Eriogonum fasciculatum var. **oleifolium** Gandoger, Bull. Soc. Bot. Belg. 42: 189. 1906.

"San Diego", *Schumo,* March 1897. Professor Robert Dovin reports that the type specimen is from the herbarium of Uselma C. Smith, Philadelphia. He adds that the collector's name, given by Gandoger as "Schamo", can as well be read "Schumo".

Eriogonum Thurberi Torrey, Bot. Mex. Bound. 176. 1859.
"Sandy ravines, San Pasqual", *Thurber,* May 1852.

Eriogonum trichopes Torrey in Emory, Notes Mil. Rec. 151. 1848.
"Eastern slope of the Cordilleras of California", *Emory,* 1846.

Eriogonum trichopes subsp. **cordatum** (Torrey) Stokes.
E. cordatum Torrey in DeCandolle, Prod. 14: 21. 1857.
"California", *Fremont;* "prope San Felippe", *Parry.*

Eriogonum verticillatum Nuttall, Jour. Acad. Phila. ser. 2. 1:165. 1848.
"Near St. Diego." Since the paper is primarily on Gambel's collections and since no collector is given for this species, Gambel's name is implied. It may be, however, that Nuttall's name was omitted accidentally. It is not certain that Gambel visited San Diego.

Eriogonum viminium subsp. **molestum** var. **glabrum** Stokes, Gen. Eriog. 51. 1936.
"Boulevard to Buckman Springs", *Stokes 67,* June 28, 1933.

Nemacaulis denudata Nuttall, Jour. Acad. Phila. ser. 2. 1: 168. 1848.
"St. Diego, Upper California, in sandy places near to the sea shore", *Nuttall,* 1836.

Nemacaulis foliosa Nuttall, Jour. Acad. Phila. ser. 2. 1: 168. 1848.
"With the above [*N. denudata*]", *Nuttall,* 1836.

CHENOPODIACEAE

Aphanisma blitoides Nuttall ex Moquin-Tandon in DeCandolle, Prod. 13 (2): 54. 1849.
"Prope San-Diego", *Nuttall,* 1836.

Atriplex pacifica A. Nelson.
Obione microcarpa Bentham, Bot. Voy. Sulphur 48. 1844.
"San Diego", *Hinds,* October 1839.

Atriplex Watsonii A. Nelson.
A. decumbens S. Watson, Proc. Am. Acad. 12: 275. 1877.
"Near San Diego", *Palmer 334,* 1876.

Obione tetraptera Bentham, Bot. Voy. Sulphur 48. 1844.
"From the coast of California, probably San Diego", *Hinds,* October 1839.

Salicornia depressa Standley, N. Am. Fl. 21: 85. 1916.
"San Diego", *K. Brandegee,* 1899.

Suaeda californica var. **pubescens** Jepson, Fl. Calif. 1: 447. 1914.
"Del Mar", *Jepson.*

AMARANTHACEAE

Amaranthus Palmeri S. Watson, Proc. Am. Acad. 12: 274. 1877.
"Larkin's Station", *Palmer 323,* August 1875.

NYCTAGINACEAE

Abronia umbellata var. **platyphylla** (Standley) Munz.
Abronia platyphylla Standley, Contr. U. S. Nat. Herb. 12: 314. 1909.
"Del Mar", *T. S. Brandegee,* May 12, 1894.

Mirabilis californica Gray in Torrey, Bot. Mex. Bound. 169. 1859.
"Dry hills, San Diego", *Parry, Thurber.*

Mirabilis Froebelii (Behr) Greene.
Oxybaphus Froebelii Behr, Proc. Calif. Acad. 1: 72. 1855.
"Prope Warner's Ranch", *Froebel.*

PORTULACACEAE

Calandrinia heterophylla Rydberg, N. Am. Fl. 21: 293. 1932.
"Old Mission Dam, San Diego County", *Chandler 5152,* April 10, 1904.

Calandrinia maritima Nuttall in Torrey & Gray, Fl. N. Am. 1: 197. 1838.
"St. Diego, California, on the sea coast", *Nuttall,* May 1836.

Calandrinia muricata Rydberg, N. Am. Fl. 21: 293. 1932.
"San Diego", *T. S. Brandegee,* April 1906.

Calyptridium monandrum Nuttall in Torrey & Gray, Fl. N. Am. 1: 198. 1838.
"St. Diego", *Nuttall,* 1836.

CARYOPHYLLACEAE

Loeflingia squarrosa Nuttall in Torrey & Gray, Fl. N. Am. 1: 174. 1838.
"Sandy plains, St. Diego", *Nuttall,* 1836.

Polycarpon depressum Nuttall in Torrey & Gray, Fl. N. Am. 1: 174. 1838.
"On bare sand-hills, near St. Diego", *Nuttall,* 1836.

Silene multinervia S. Watson, Proc. Am. Acad. 25: 126. 1890.
"Jamuel, San Diego County", *Orcutt,* April 1885; also Santa Cruz Island. According to Abrams (1944, p. 160) the type locality is Jamul.

Silene Palmeri S. Watson, Proc. Am. Acad. 11: 124. 1876.
"Cuyamaca Mountains", *Palmer,* August 1875.

Silene verecunda var. **platyota** (S. Watson) Jepson.
S. platyota S. Watson, Proc. Am. Acad. 17: 366. 1882.

"Cuyamaca Mountains", *Palmer,* 1875; also San Bernardino and San Jacinto Mountains. According to Abrams (1944, p. 167) the type locality is Cuyamaca Mountains.

Spergularia Clevelandii (Greene) Robinson.
Tissa Clevelandii Greene, Fl. Fran. 127. 1891.

"Formerly abundant on rather sandy uplands about San Diego"; also San Francisco.

RANUNCULACEAE

Aquilegia hypolasia Greene, Leafl. Bot. Obs. 2: 141. 1911.

"Between Campbell's and Cameron's ranches", *Mearns 3657,* June 21, 1894; also between Pine Valley and Laguna. According to Munz (1946, p. 106) the type is *Mearns 3657.*

Clematis lasiantha Nuttall in Torrey & Gray, Fl. N. Am. 1: 9. 1838.

"With the preceding [*C. pauciflora*]", *Nuttall,* 1836.

Clematis pauciflora Nuttall in Torrey & Gray, Fl. N. Am. 1: 9, 657. 1838, 1840.

"Near the sea-coast of St. Diego". *Nuttall,* 1836.

Delphinium coccineum Torrey, Pacif. Railr. Rep. 4: 62. 1857.

"Mountains east of San Diego", *Parry,* 1850.

Delphinium collinum Ewan, Bull. Torrey Club 63: 338. 1936.

"Ridge betw. Campbells Ranch and Mason Valley". *Epling and Robison,* April 4, 1932.

Delphinium cuyamacae Abrams, Bull. Torrey Club 32: 538. 1905.

"Grassy slopes bordering Cuyamaca Lake, altitude 1550 meters", *Abrams 3888,* June 26, 1902.

Delphinium Parryi var. **subglobosum** (Wiggins) Munz.
D. subglobosum Wiggins, Contr. Dudley Herb. 1: 99. 1929.

"Open grassy slope near Banner", *Wiggins 2003,* March 20, 1926.

Myosurus minimus var. **apus** Greene, Bull. Calif. Acad. 1: 277. 1885.

"Table-lands back of San Diego", *Orcutt,* April 10, 1884.

Thalictrum coreospermum Greene, Repert. Nov. Sp. 7: 253. 1909.

"Cuyamaca Mountains", *Orcutt,* July 1889.

Thalictrum magarum Greene, Muhlenbergia 5: 130. 1909.

"Witch Creek", *Alderson,* April 1894.

BERBERIDACEAE

Berberis Higginsae Munz, Aliso 4: 91. 1958.
"Dry rocky point at Boulevard", *Johnson and Stark 1351,* July 12, 1929.

PAPAVERACEAE

Dendromecon saligna Greene, Pittonia 5: 300. 1905.
"Encenitas", *T. S. Brandegee.*

Eschscholtzia Clevelandii Greene, Pittonia 5: 248. 1905.
"At and near San Diego", and southward into Baja California.

Eschscholtzia floribunda Greene, Pittonia 5: 247. 1905.
"Near Santa Ysabel", *Henshaw,* May 15, 1893.

Eschscholtzia physodes Greene, Pittonia 5: 259. 1905.
"Witch Creek", *Alderson,* April 1894.

Eschscholtzia sanctarum Greene, Pittonia 5: 243. 1905.
"Grand Mesa", *Greene?,* May 1894.

Meconella kakoethes Fedde, Repert. Nov. Sp. 3: 275. 1907.
"San Diego", *Orcutt,* 1895.

Platystemon californicus var. **nutans** T. S. Brandegee, Zoe 5: 177. 1903.
"About San Diego and on many of the islands off the coast."

Platystemon obtectus Greene, Pittonia 5: 186. 1903.
"Witch Creek", *Alderson,* May 24, 1894.

Platystemon verecundus var. **glabrifructifer** Fedde, Pflanzenr. 4 (104): 131. 1909.
"San Diego", *Greene; Palmer 8a,* 1875.

CAPPARIDACEAE

Isomeris arborea Nuttall in Torrey & Gray, Fl. N. Am. 1: 124. 1838.
"St. Diego", *Nuttall,* 1836.

Wislizenia divaricata Greene, Proc. Biol. Soc. Wash. 19: 130. 1906.
"Bonego Springs . . . southern part of the Colorado Desert in San Diego County", *Orcutt,* June 23, 1888. Clearly Borrego Springs is meant.

CRUCIFERAE

Agianthus Jacobaeus Greene, Leafl. Bot. Obs. 1: 229. 1906.
"Cuyamaca Mountains", *Orcutt 1507,* July 1889.

Arabis pulchra var. **glabrescens** Wiggins, Contr. Dudley Herb. 1: 100. 1929.
"Gravelly slope between Julian and Banner", *Wiggins 2015,* March 20, 1926.

Arabis pulchra var. **viridis** Jepson, Fl. Calif. 2: 70. 1936.
"Summit of Mountain Springs grade", *Jepson 11810.*

Arabis sparsiflora var. **californica** Rollins, Rhodora 43: 402. 1941.
"Near Campo", *Abrams 3563,* May 24, 1903.

Caulanthus heterophyllus (Nuttall) Payson.
Streptanthus heterophyllus Nuttall in Torrey & Gray, Fl. N. Am. 1: 77. 1838.
"Bushy hills, near St. Diego", *Nuttall,* 1836.

Caulanthus stenocarpus Payson, Ann. Missouri Bot. Gard. 9: 300. 1923.
"Dry hillsides near Bernardo", *Abrams 3364,* May 1, 1903.

Lepidium acutidens var. **microcarpum** Thellung, Mitt. Bot. Mus. Univ. Zürich 28: 271. 1906.
"San Diego", *Jones 3061,* 1882; also *Pringle,* 1882.

Lepidium flavum var. **felipense** C. L. Hitchcock, Madroño 3: 299. 1936.
"San Felipe", *Purpus,* 1898.

Lepidium Robinsonii Thellung, Mitt. Bot. Mus. Univ. Zürich 28: 255. 1906.
"San Diego", *Jones 3050,* 1882; also *Orcutt 1039.* According to C. L. Hitchcock (1936, p. 285) the type apparently is *Jones 3050.*

Streptanthus campestris S. Watson, Proc. Am. Acad. 25: 125. 1890.
"Campo", *Vasey and Parish,* 1880.

Thysanocarpus laciniatus var. **rigidus** Munz, Bull. So. Calif. Acad. 31: 62. 1932.
"Laguna Camp, Laguna Mts.", *Munz 9701,* May 16, 1925.

CRASSULACEAE

Dudleya Abramsii Rose, Bull. N. Y. Bot. Gard. 3: 14. 1903.
"Wet crevices of rocks west of Jacumba", *Abrams 3707,* June 1, 1903.

Dudleya aloides Rose, Bull. N. Y. Bot. Gard. 3: 15. 1903.
"San Felipe", *Orcutt,* April 1903.

Dudleya delicata Rose, Bull. N. Y. Bot. Gard. 3: 24. 1903.
"Spencer Valley", *Abrams 3791,* June 22, 1903.

Dudleya lagunensis (Munz) E. Walther.
Echeveria lagunensis Munz, Bull. So. Calif. Acad. 31: 64. 1932.
"Dry stony slopes, Campbell Ranch, Vallecito Valley", *Munz and C. L. Hitchcock 12612,* April 3, 1932.

Dudleya lanceolata (Nuttall) Britton & Rose.
Echeveria lanceolata Nuttall in Torrey & Gray, Fl. N. Am. 1: 561. 1840.
"St. Diego", *Nuttall*, 1836.

Dudleya pulverulenta (Nuttall) Britton & Rose.
Echeveria pulverulenta Nuttall in Torrey & Gray, Fl. N. Am. 1: 560. 1840.
"St. Diego", *Nuttall*, 1836.

Hasseanthus Blochmaniae subsp. **brevifolius** Moran, Des. Pl. Life 22: 80. 1950.
"Open area in chaparral near edge of mesa, Torrey Pines Park", *Moran 3206*, April 9, 1949.

Sedum variegatum S. Watson, Proc. Am. Acad. 11: 137. 1876.
"San Diego", *Cleveland*, May 1875.

Stylophyllum edule (Nuttall) Britton & Rose.
Sedum edule Nuttall in Torrey & Gray, Fl. N. Am. 1: 560. 1840.
"Edges of rocks and ravines, St. Diego", *Nuttall*, 1836.

Stylophyllum Orcuttii Rose, Bull. N. Y. Bot. Gard. 3: 36. 1903.
"Initial Mexican boundary monument", *T. S. Brandegee*.

Stylophyllum Parishii Britton, Bull. N. Y. Bot. Gard. 3: 37. 1903.
"Pala", *S. B. and W. F. Parish 444*, June 1880.

Tillaea erecta var. **eremica** Jepson, Man. Fl. Pl. Calif. 450. 1925.
"Vallecito", *Jepson 8636*.

SAXIFRAGACEAE

Heuchera brevistaminea Wiggins, Contr. Dudley Herb. 1: 100. 1929.
"Shallow soil on a rocky canyon slope a half-mile below Vallecitos View, Laguna Mountains", *Wiggins 2831*, September 4, 1927.

Jepsonia Parryi (Torrey) Small.
Saxifraga Parryi Torrey, Bot. Mex. Bound. 69. 1859.
"Dry hills near San Diego and San Luis Rey", *Parry*.

Lithophragma trifida Eastwood ex Rydberg, N. Am. Fl. 22: 89. 1905.
"Near Sweetwater Dam", *Eastwood*.

Ribes canthariformis Wiggins, Contr. Dudley Herb. 1: 101. 1929.
"In chaparral on a northeast slope near Moreno Dam", *Wiggins 2399*, April 14, 1927. The type plant has been destroyed during road construction, but others are still to be found in the immediate vicinity.

Ribes indecorum Eastwood, Proc. Calif. Acad. ser. 3. 2: 243. 1902.
"Cajon Heights, near San Diego", *Eastwood*, March 14, 1891.

ROSACEAE

Adenostoma fasciculatum var. **obtusifolium** S. Watson, Bot. Calif. 1: 184. 1876.
A. brevifolium Nuttall ex Rydberg, N. Am. Fl. 22: 396. 1913.
"Near San Diego", *Nuttall,* 1836.

Adenostoma laxum Gandoger, Bull. Soc. Bot. Fr. 59: 707. 1912.
"San Diego", *Brandegee;* also Mendocino.

Adenostoma sparsifolium Torrey in Emory, Notes Mil. Rec. 140. 1848.
"Cordilleras of California", *Emory,* December 2, 1846. According to Abrams (1910, p. 378) the locality is near Warners Ranch.

Amelanchier alnifolia var. **cuyamacensis** Munz, Bull. So. Calif. Acad. 31: 65. 1932.
"Cuyamaca Lake", *Munz 8099.*

Cercocarpus minutiflorus Abrams, Bull. Torrey Club 37: 149. 1910.
"Dry chaparral-covered hills, near San Dieguito (Bernardo)", *Abrams 3376,* May 4, 1903.

Potentilla Bolanderi var. **Clevelandii** (Greene) Munz & Johnston.
P. Clevelandii Greene, Pittonia 1: 102. 1887.
"At Laguna, in the mountains back of San Diego", *Cleveland,* July 1885.

Potentilla Parishii Rydberg, N. Am. Fl. 22: 313. 1908.
"Descanso", *S. B. Parish 4523,* 1897.

Potentilla truncata (Rydberg) Munz & Johnston.
Horkelia truncata Rydberg, N. Am. Fl. 22: 274. 1908.
"Type collected in Brandegee's garden at San Diego, cultivated plant brought from Ramona", *Chandler 5321.*

Prunus fremontii S. Watson, Bot. Calif. 2: 442. 1880.
"Oriflamme Cañon", *Cleveland;* also San Bernardino Mountains. According to Jepson (1936, p. 229) and Abrams (1944, p. 466) the type locality is Oriflamme Canyon.

Prunus fremontii var. **pilulata** Jepson, Man. Fl. Pl. Calif. 507. 1925.
"Wagon Wash near Sentenac Cañon", *Jepson 8769.*

Rosa Aldersonii Greene, Pittonia 5: 110. 1903.
"Witch Creek", *Alderson,* June 1894.

Rubus Ganderi Bailey, Gent. Herb. 5: 893. 1945.
"North Peak, Cuyamaca Mountains", *Gander A208.*

Rubus parviflorus forma **villosus** Fassett, Ann. Missouri Bot. Gard. 28: 324. 1941.

"Near head of Nigger Grade, Palomar Mt.", *Gander 6239*, August 4, 1938. Specimens of this collection were referred by Fassett to four formae belonging to two varieties.

LEGUMINOSAE

Amorpha occidentalis Abrams, Bull. N. Y. Bot. Gard. 6: 394. 1910.

"San Diego River, near the Old San Diego Mission", *Abrams 3425*, May 6, 1903.

Astragalus agninus Jepson, Man. Fl. Pl. Calif. 577. 1925.

"Borrego Sprs.", *Jepson 8883*.

Astragalus coccineus (Parry) T. S. Brandegee.
A. Purshii var. *coccineus* Parry, West. Am. Sci. 7: 10. 1890.

"Western borders of the Colorado Desert", *Orcutt 1514*. According to Jepson (1936, p. 359) the type locality is Mountain Springs.

Astragalus Douglasii var. **perstrictus** (Rydberg) Munz & McBurney.
Phaca perstricta Rydberg, N. Am. Fl. 24: 344. 1929.

"In a hill valley between Campo and Jocumba", *Abrams 3636*, May 28, 1903.

Astragalus lentiginosus var. **borreganus** M. E. Jones, Contr. West. Bot. 8: 3. 1898.

"Borregos Springs", *Orcutt*.

Astragalus leucopsis var. **lonchus** M. E. Jones, Rev. N. Am. Astrag. 119. 1923.

"San Diego", *Jones 3083*.

Astragalus oocarpus A. Gray, Proc. Am. Acad. 6: 213. 1864.

"Mountains east of San Diego", *Parry*.

Astragalus pomonensis M. E. Jones, Contr. West. Bot. 10: 59. 1902.

"On the tableland of Fallbrook", *Jones*, 1882.

Astragalus Vaseyi S. Watson, Proc. Am. Acad. 17: 370. 1882.

"Mountain Springs". *Vasey*, 1880.

Cercis nephrophylla Greene, Repert. Sp. Nov. 11: 111. 1912.

"Some uncertain mountain district in southwestern California, in San Diego County", *Palmer*; *Vasey*, 1875.

Hosackia argophylla A. Gray, Mem. Am. Acad. ser. 2. 5: 316. 1854.

"San Isabel, California, on rocks", *Thurber*, May 1852.

Hosackia micrantha Nuttall in Torrey & Gray, Fl. N. Am. 1: 324. 1838.
"Near Monterey", *Nuttall,* 1836. According to Abrams (1944, p. 551) this is an error, the specimen probably having been collected at San Diego.

Hosackia prostrata Nuttall in Torrey & Gray, Fl. N. Am. 1: 325. 1838.
"Plains near the sea; St. Diego, and St. Barbara", *Nuttall,* 1836.

Krameria parvifolia var. **imparata** Macbride, Contr. Gray Herb. 56: 52. 1918.
"Mountain Springs", *Spencer 763.*

Lathyrus splendens Kellogg, Proc. Calif. Acad. 7: 90. 1876.
"Southern California", *Hutchings.*

Lathyrus strictus Nuttall in Torrey & Gray, Fl. N. Am. 1: 276. 1838.
"Bushy places around St. Diego", *Nuttall,* April 1836.

Lotus confinis Greene, Erythea 1: 258. 1893.
"In the mountains of San Diego Co., Calif., near the United States and Mexican boundary", *Alderson,* 1893.

Lotus Spencerae Macbride, Contr. Gray Herb. 53: 13. 1918.
"Stony slopes, Mountain Springs", *Spencer 561,* March 18, 1917.

Lupinus albifrons var. **medius** Jepson, Fl. Calif. 2: 252. 1936.
"Mountain Springs grade (at summit)", *Jepson 11815.*

Lupinus Brittonii Abrams, Bull. N. Y. Bot. Gard. 6: 391. 1910.
"Cottonwood Valley", *Abrams 3904,* June 5, 1903.

Lupinus Chamissonis var. **longifolius** S. Watson, Bot. Calif. 1: 117. 1876.
"San Diego", *Cleveland.* According to Jepson (1936, p. 253) this is the type locality.

Lupinus densiflorus var. **austrocollium** C. P. Smith, Bull. Torrey Club 45: 200. 1918.
"Near St. Mary's hospital, San Diego", *Abrams 3465,* May 12, 1903. Apparently St. Joseph's Hospital (now Mercy Hospital) was meant.

Lupinus micranthus var. **microphyllus** S. Watson, Proc. Am. Acad. 8: 535. 1873.
"San Diego", *Nuttall,* 1836.

Lupinus sparsiflorus var. **inopinatus** C. P. Smith, Bull. Torrey Club 47: 499. 1920.
"San Diego", *T. S. Brandegee,* April 1903.

Lupinus truncatus Nuttall ex Hooker & Arnott, Bot. Beechey Voy. 336. 1840.
"San Diego", *Nuttall,* 1836.

Phaca Deanei Rydberg, N. Am. Fl. 24: 355. 1929.
"Sweetwater Valley", *Deane,* May 13, 1883.

Phaca pseudoocarpa Rydberg, N. Am. Fl. 24: 343. 1929.
"Cuiamaca Mountains", *Palmer 68,* 1875.

Pickeringia montana var. **tomentosa** (Abrams) Johnston.
Xylothermia montana subsp. *tomentosa* Abrams, Bull. Torrey Club 34: 263. 1907.
"Near El Nido", *Abrams 3530,* May 20, 1903.

Psoralea rigida Parish, Bull. Torrey Club 19: 91. 1892.
"Dry hills, Oak Grove", *S. B. Parish 643,* June 1882.

Thermopsis macrophylla var. **senota** Jepson, Fl. Calif. 2: 245. 1936.
"Spencer Valley", *Alderson.*

Trifolium anodon Greene, Pittonia 5: 107. 1903.
"San Diego", *T. S. Brandegee.*

Trifolium decodon Greene, Pittonia 5: 108. 1903.
"San Diego", *T. S. Brandegee,* May 20, 1903.

OXALIDACEAE

Oxalis californica (Abrams) R. Knuth.
Xanthoxalis californica Abrams, Bull. Torrey Club 34: 264. 1907.
"Onofre Mountains", *Abrams 3274,* April 19, 1903.

RUTACEAE

Cneoridium dumosum (Nuttall) Hooker f.
Pitavia dumosa Nuttall in Torrey & Gray, Fl. N. Am. 1: 215. 1838.
"St. Diego", *Nuttall,* 1836.

EUPHORBIACEAE

Croton californicus var. **tenuis** (S. Watson) Ferguson.
Croton tenuis S. Watson, Proc. Am. Acad. 14: 297. 1879.
"Potrero", *Cleveland 836,* 1876.

Euphorbia cinerascens var. **appendiculata** Engelmann, Bot. Mex. Bound. 186. 1859.
"San Felipe", *Thurber 628,* May 1852. Although two other collections also were cited, this one is the type according to Wheeler (1941, p. 188).

Euphorbia hirtula Engelmann ex S. Watson, Bot. Calif. 2: 74. 1880.
"Talley's in the Cuyamaca Mountains", *Palmer,* July 1875. This is the type locality according to Abrams (1951, p. 39).

Euphorbia misera Bentham, Bot. Voy. Sulphur 51. 1844.

"San Diego", *Hinds,* 1839; also San Quentin.

Euphorbia Palmeri Engelmann ex S. Watson, Bot. Calif. 2: 75. 1880.

"Talley's Ranch in the Cuyamaca Mountains", *Palmer 450,* July 1875.

Euphorbia patellifera J. T. Howell, Leafl. West. Bot. 1: 53. 1933.

"Near Palm Wash", *Howell 3488.* According to a letter from Mr. Howell, the locality is 5 miles west of highway U. S. 99, in the first wash north of Palm Wash, 35 highway miles south of Indio.

Stillingia linearifolia S. Watson, Proc. Am. Acad. 14: 297. 1879.

"Near Boundary Monument, San Diego", *Palmer 449,* September 1875; also San Bernardino.

CALLITRICHACEAE

Callitriche marginata var. **longipedunculata** (Morong) Jepson.
C. longipedunculata Morong, Bull. Torrey Club 18: 236. 1891.

"On mesas, San Diego", *Orcutt,* 1884.

BUXACEAE

Simmondsia californica Nuttall, Lond. Jour. Bot. 3: 401. 1844.

"Covering the sides of barren hills, in argillaceous soils, near the sea, in the vicinity of St. Diego", *Nuttall,* 1836.

LIMNANTHACEAE

Limnanthes versicolor var. **Parishii** Jepson, Fl. Calif. 2: 412. 1936.

"Stonewall Mine, Cuyamaca Mts.", *S. B. Parish 4416.*

ANACARDIACEAE

Rhus integrifolia (Nuttall) Bentham & Hooker.
Styphonia integrifolia Nuttall in Torrey & Gray, Fl. N. Am. 1: 220. 1838.

"On the margins of cliffs, &c. near the sea, around St. Diego & St. Barbara; common", *Nuttall,* 1836.

Schmaltzia cruciata Greene, Leafl. Bot. Obs. 1: 139. 1905.

"Hot Springs in the northern part of San Diego Co.", *Palmer,* 1875. According to McVaugh (1956, p. 225) this apparently is Warners Hot Springs.

Styphonia serrata Nuttall in Torrey & Gray, Fl. N. Am. 1: 220. 1838.

"With the preceding [*S. integrifolia*]", *Nuttall,* 1836.

Toxicodendron comarophyllum Greene, Leafl. Bot. Obs. 1: 120. 1905.
"Tighe's, near San Diego", *Palmer*, July 1875.

RHAMNACEAE

Adolphia californica S. Watson, Proc. Am. Acad. 11: 126. 1876.
"At Solidad and Chollas Valley, near San Diego, and near Monterey", *Parry, Cleveland, Palmer.* As pointed out by Abrams (1910, p. 415) the last-named station is unquestionably an error.

Ceanothus austromontanus Abrams, Bull. N. Y. Bot. Gard. 6: 412. 1910.
"Coniferous forests, between Julian and Cuiamaca", *Abrams 3966*, July 1, 1903.

Ceanothus cyaneus Eastwood, Proc. Calif. Acad. ser. 4. 16: 361. 1927.
"Lakeside", *Philbrook*, April 1920.

Ceanothus divaricatus var. **laetiflorus** Jepson, Man. Fl. Pl. Calif. 620. 1925.
"Palomar Mt. (Pala Mission)". *Jepson 8494.*

Ceanothus Orcuttii Parry, Proc. Davenp. Acad. 5: 194. 1889.
"High mountains east of San Diego", *Orcutt*, May and July 1889. According to Orcutt (1909, col. 548) the locality is Cuyamaca.

Ceanothus ×otayensis McMinn, Ceanothus 273. 1942.
"Otay Mountain", *Jensen 401*, January 20, 1935.

Ceanothus Palmeri Trelease, Proc. Calif. Acad. ser. 2. 1: 109. 1888.
"Mountains of Southern California", *Palmer 42*, 1875. According to Abrams (1951, p. 71) the type locality is Cuyamaca Mountains.

Ceanothus tomentosus var. **olivaceus** Jepson, Man. Fl. Pl. Calif. 621. 1925.
"Clevenger Cañon, Ramona", *Jepson 8509.*

Ceanothus verrucosus Nuttall in Torrey & Gray, Fl. N. Am. 1: 267. 1838.
"Low hills near the coast, St. Diego", *Nuttall*, 1836.

Condalia Parryi (Torrey) Weberbauer.
Zizyphus Parryi Torrey, Bot. Mex. Bound. 46. 1859.
"Gravelly ravines near San Felipe", *Parry*, June 1850.

Rhamnus crocea var. **pilosa** Trelease ex Curran, Proc. Calif. Acad. ser. 2. 1:251. 1888.
"Santa Maria Valley, in the mountains back of San Diego." According to Wolf (1938, p. 39) the type specimen is labeled "Nuevo, M. K. Curran, July, 1885". Nuevo is an old name for Ramona, which is in the Santa Maria Valley.

VITACEAE

Vitis Girdiana Munson, Proc. Soc. Prom. Agr. Sci. 8: 59. 1887.
"San Diego Co.", *Gird;* also Los Angeles County.

MALVACEAE

Malvastrum densiflorum var. **viscidum** (Abrams) Estes.
M. viscidum Abrams, Bull. Torrey Club 34: 264. 1907.
"Dry hillsides near El Nido", *Abrams 3528,* May 19, 1903.

Malvastrum fasciculatum (Nuttall) Greene.
Malva fasciculata Nuttall in Torrey & Gray, Fl. N. Am. 1: 225. 1838.
"St. Barbara". *Nuttall,* 1836. According to Abrams (1910, p. 417) "Nuttall's specimens are like the form occurring at San Diego, where he probably obtained his specimens, as the species has not since been found at Santa Barbara.

Saviniona suspensa Greene, Leafl. Bot. Obs. 2: 162. 1911.
"San Diego", *Vasey,* 1889.

Sphaeralcea purpurea Parish ex Jepson, Man. Fl. Pl. Calif. 635. 1925.
"Mountain Spr."; also Coyote Well.

STERCULIACEAE

Fremontia californica var. **diegensis** M. Harvey, Madroño 7: 108. 1942.
"Bottom of Vallecito Canyon, Laguna Mountains", *Munz 9716,* May 17, 1925.

CISTACEAE

Helianthemum scoparium var. **Aldersonii** (Greene) Munz.
H. Aldersonii Greene, Erythea 1: 259. 1893.
"Mountains of the southern borders of San Diego Co., Calif., among rocks in hard and sterile granitic soil", *Alderson,* June 1893.

CACTACEAE

Bergerocactus Emoryi (Engelmann) Britton & Rose.
Cereus Emoryi Engelmann, Am. Jour. Sci. ser. 2. 14: 338. 1852.
"On dry hills near the sea shore, about the boundary line", *Parry,* 1850.

Cereus? californicus (Nuttall) Torrey & Gray, Fl. N. Am. 1: 555. 1840.
"Arid hills and denuded tracts near St. Diego, California, common" *Nuttall,* 1836.

Echinocactus limitus Engelmann in Coulter, Contr. U. S. Nat. Herb. 3: 374. 1896.

"Boundary line south of San Diego", *G. M. Hitchcock,* 1876.

Echinocactus viridescens var. **cylindraceus** Engelmann, Am. Jour. Sci. ser. 2. 14: 338. 1852.

"Near San Felipe", *Parry.*

Echinocereus Engelmannii (Parry) Rümpler.

Cereus Engelmannii Parry ex Engelmann, Am. Jour. Sci. ser. 2. 14: 338. 1852.

"Mountains about San Felipe, on the eastern declivity of the Cordilleras", *Parry.*

Ferocactus viridescens (Nuttall) Britton & Rose.

Echinocactus? viridescens (Nuttall) Torrey & Gray, Fl. N. Am. 1: 554. 1840.

"Arid hills &c. near St. Diego", *Nuttall,* 1836.

Mammillaria incerta Parish in Jepson, Fl. Calif. 2: 549. 1936.

"Vallecito", *Parish 450.*

Mammillaria tetrancistra Engelmann, Am. Jour. Sci. ser. 2. 14: 337. 1852.

"From San Diego to the junction of the Gila with the Colorado", *Parry.*

Opuntia acanthocarpa subsp. **Ganderi** Wolf, Occ. Pap. Rancho Santa Ana Bot. Gard. 2: 75. 1938.

"3 mi. below the old Vallecito Stage Station", *Wolf 9424,* June 12, 1938.

Opuntia demissa Griffiths, Missouri Bot. Gard. Rep. 22: 29. 1912.

"East of San Diego", *Griffiths 9647,* April 2, 1909.

Opuntia echinocarpa var. **Parkeri** (Engelmann) Coulter, Contr. U. S. Nat. Herb. 3: 446. 1896.

"San Diego County, California, east side of mountains facing desert", *J. C. Parker,* September 1879. The collector's name was originally given as "C. F. Parker", perhaps through confusion with Charles F. Parker (1820-1883), concerning whom see Ewan (1950, p. 277). According to Dr. Lyman Benson, however, a slip with the type specimen reads "Campo, on the eastern slope toward the desert, J. C. Parker, Sept. 1879".

Opuntia Fosbergii Wolf.

O. Bigelovii var. *Hoffmannii* Fosberg in Pierce & Fosberg, Bull. So. Calif. Acad. 32: 121. 1933.

"Alluvial fan at the mouth of Cane Brakes Canyon, at the eastern base of the Laguna Mountains", *Fosberg 8602.*

Opuntia Parryi Engelmann, Am. Jour. Sci. ser. 2. 14: 339. 1852.

"Eastern slope of the California mountains, near San Felipe", *Parry.*

Opuntia prolifera Engelmann, Am. Jour. Sci. ser. 2. 14: 338. 1852.

"San Diego, on arid hills and in dry creek beds", *Parry.*

Opuntia serpentina Engelmann, Am. Jour. Sci. ser. 2. 14: 338. 1852.
"Dry hillsides, San Diego", *Parry.*

ONAGRACEAE

Clarkia delicata (Abrams) Nelson & Macbride.
Godetia delicata Abrams, Bull. Torrey Club 32: 539. 1905.
"Frequent on shady slopes between Potrero and Campo", *Abrams 3710,* June 3, 1903.

Epilobium Palmeri Léveillé, Repert. Sp. Nov. 5: 98. 1908.
"Cuimaca Mts.", *Palmer 5368,* June 27, 1875.

Gayophytum lasiospermum Greene, Pittonia 2: 164. 1891.
"Near Julian", *Dunn,* August 1888.

Godetia epilobioides (Nuttall) S. Watson.
Oenothera epilobioides Nuttall in Torrey & Gray, Fl. N. Am. 1: 511. 1840.
"St. Diego", *Nuttall,* May 1836.

Oenothera bistorta Torrey & Gray, Fl. N. Am. 1: 508. 1840.
"St. Diego", *Nuttall,* 1836.

Oenothera leptocarpa Greene.
Eulobus californicus Nuttall in Torrey & Gray, Fl. N. Am. 1: 515. 1840.
"Bushy plains near St. Diego", *Nuttall,* April 1836.

Oenothera spiralis var. **linearis** Jepson, Man. Fl. Pl. Calif. 684. 1925.
"Sunnyside", *Hall 3908.*

Oenothera trichocalyx var. **cineracea** Jepson, Man. Fl. Pl. Calif. 681. 1925.
"Borrego Spr.", *T. S. Brandegee.*

UMBELLIFERAE

Apiastrum angustifolium Nuttall in Torrey & Gray, Fl. N. Am. 1: 644. 1840.
"St. Diego", *Nuttall,* April 1836.

Apiastrum angustifolium var. **tenellum** Nuttall in Torrey & Gray, Fl. N. Am. 1: 644. 1840.
Apparently with the preceding.

Apiastrum latifolium Nuttall in Torrey & Gray, Fl. N. Am. 1: 644. 1840.
"With the preceding [*A. angustifolium*]", *Nuttall,* April 1836.

Eryngium Parishii Coulter & Rose, Contr. U. S. Nat. Herb. 7: 57. 1900.
"Oceanside", *S. B. Parish 4436,* 1897.

Euryptera lucida Nuttall in Torrey & Gray, Fl. N. Am. 1: 629. 1840.
"Woods of St. Diego", *Nuttall,* April 1836.

Peucedanum Pringlei Coulter & Rose, Bot. Gaz. 13: 209. 1888.
"San Diego county". *Pringle, Parry, Vasey.*

Sanicula arguta Greene ex Coulter & Rose, Contr. U. S. Nat. Herb. 7: 36. 1900.
"Hills near San Diego", *Pringle,* 1882.

Velaea arguta (Nuttall) Coulter & Rose.
Deweya arguta (Nuttall) Torrey & Gray, Fl. N. Am. 1: 641. 1840.
"Woods of St. Diego", *Nuttall,* April 1836.

Velaea arguta var. **ternata** Coulter & Rose, Bot. Gaz. 14: 282. 1889.
"Cuyamaca Mountains", *Orcutt,* July 1889.

GARRYACEAE

Garrya Veatchii var. **Palmeri** (S. Watson) Eastwood.
G. flavescens var. *Palmeri* S. Watson, Bot. Calif. 1: 276. 1876.
"Milquatay, 60 miles from San Diego, on the Fort Yuma road", *Palmer,* 1875.

LENNOACEAE

Pholisma arenarium Nuttall ex Hooker, Hook. Ic. 7: pl. 626. 1844.
"Monterey and San Diego", *Nuttall,* 1836. As pointed out by Jepson (1939, p. 17) this plant has not since been found at Monterey, and the citation probably is an error.

ERICACEAE

Arctostaphylos Clevelandii A. Gray, Proc. Am. Acad. 12: 61. 1876.
"Potrero", *Cleveland,* September 20, 1876.

Arctostaphylos drupacea (Parry) Macbride.
A. Pringlei var. *drupacea* Parry, Bull. Calif. Acad. 2: 495. 1887.
"Mountains east of San Diego", *Orcutt 543,* September 1886.

Arctostaphylos glandulosa var. **adamsii** Munz, Aliso 4: 95. 1958.
"Dry granitic slopes and benches, north end of Laguna Mts., on highway to Julian, at 5000 feet", *Munz and Balls 17958,* August 20, 1952.

Arctostaphylos glandulosa var. **australis** Adams, Jour. Elisha Mitchell Soc. 56: 51. 1940.
"West slopes of Otay Mountain", *Adams 974a.*

Arctostaphylos glandulosa var. **crassifolia** Jepson, Madroño 1: 86. 1922.
"Del Mar", *Jepson 1606a.*

Arctostaphylos otayensis Wieslander & Schreiber, Madroño 5: 43. 1939.
"Otay Mountain", *Jensen, Wieslander.*

Comarostaphylis diversifolia (Parry) Greene.
Arctostaphylos arguta var. *diversifolia* Parry, Proc. Davenp. Acad. 4: 35. 1884.
"Jamul Valley", *Sanford.* Other localities were mentioned, but according to Abrams (1910, p. 431) this is the type locality.

Xylococcus bicolor Nuttall, Trans. Am. Philos. Soc. ser. 2. 8:259. 1843.
"Monterey", *Nuttall,* 1836. As pointed out by Abrams (1910, p. 431) the species is not known in the Monterey region, and Nuttall's specimen doubtless came from San Diego.

PRIMULACEAE

Dodecatheon Clevelandii Greene, Pittonia 1: 213. 1888.
"Dry hills and mesas in the southern part of California, about San Diego and San Bernardino."

PLUMBAGINACEAE

Limonium mexicanum Blake, Rhodora 18: 59. 1916.
"San Diego", *Palmer 216,* 1876.

GENTIANACEAE

Swertia Parryi (Torrey) Kuntze.
Frasera Parryi Torrey, Pacif. Railr. Rep. 4: 126. 1857.
"Mountains east of San Diego", *Parry.*

ASCLEPIADACEAE

Asclepias californica Greene.
Acerates tomentosa Torrey, Bot. Mex. Bound. 160. 1859.
"Mountains east of San Diego", *Parry,* June 1850; "San Isabel", *Thurber,* 1852.

Gonolobus californicus Jepson, Man. Fl. Pl. Calif. 771. 1925.
"Ironwood Well [Yaqui Well]", *T. S. Brandegee.*

CONVOLVULACEAE

Convolvulus aridus subsp. **longilobus** Abrams, Contr. Dudley Herb. 3: 358. 1946.
"San Diego", *Stokes,* June 1895.

Convolvulus aridus subsp. **tenuifolius** Abrams, Contr. Dudley Herb. 3: 359. 1946.

"Hills near Bernardo (San Dieguito)", *Abrams 3363*, May 1, 1903.

Dichondra occidentalis House, Muhlenbergia 1: 130. 1906.

"San Diego", *Orcutt*, January 7, 1884.

POLEMONIACEAE

Eriastrum densifolium subsp. **austromontanum** (Craig) Mason.
Gilia densifolia var. *austromontana* Craig, Bull. Torrey Club 61: 391. 1934.

"Dry slope near Nellie, Palomar Mts.", *Munz 8341*, 1924.

Fenzlia concinna Nuttall, Proc. Acad. Phila. 4: 12. 1848.

"Near Santa Diego", *Nuttall*, May 1836.

Gilia caruifolia Abrams, Bull. Torrey Club 32: 540. 1905.

"Cuyamaca Mountains, between Cuyamaca Lake and Oriflamme Cañon", *Abrams 3940*, June 28, 1903.

Gilia floribunda A. Gray, Proc. Am. Acad. 8: 267. 1870.

"California, probably on S. E. borders", *Coulter 454*. Other specimens also were cited, but according to Mason (in Abrams 1951, p. 431) this is the type. It is likely that Coulter collected this specimen in San Diego County on his trip to the Colorado River in 1832.

Gilia inconspicua var. **diegensis** Munz, Man. So. Calif. Bot. 599. 1935.

"Under pines, at 5000 ft., Laguna Mts.", *Munz 9694*.

Gilia lutea var. **longistylis** Munz, Man. So. Calif. Bot. 599. 1935.

"San Diego", *Baker 1608*.

Gilia truncata Davidson, Bull. So. Calif. Acad. 22: 72. 1923.

"Near Jacumba", *Kessler*, April 1923 (*Davidson 3572*). According to a letter from Theodore Payne, this specimen was collected by Kessler.

Linanthus androsaceus subsp. **luteolus** (Greene) Mason.
L. luteolus Greene, Erythea 3: 121. 1895.

"Cuyamaca Mountains", *Vasey*, June 1880. Another specimen also was cited, but according to Mason (in Abrams 1951, p. 430) this is the type.

Navarretia densifolia var. **jacumbana** Brand, Annu. Conserv. & Jard. Bot. Genève 15-16: 340. 1913.

"Desert slopes, Jacumba", *Abrams 3640*, May 29, 1903.

Navarretia hamata subsp. **foliacea** (Greene) Mason.
N. foliacea Greene, Pittonia 1: 138. 1887.

"San Diego", *Orcutt;* also Potrero. According to Mason (in Abrams 1951, p. 451) the type locality is San Diego.

Navarretia macrantha Brand, Pflanzenreich 4(250): 154. 1907.
"Hügel zwischen Foster und Ramona", *Abrams 3765;* also San Bernardino and San Luis Obispo Counties.

HYDROPHYLLACEAE

Eriodictyon crassifolium Bentham, Bot. Voy. Sulphur 35. 1844.
"San Diego", *Barclay,* October 1839.

Eriodictyon trichocalyx var. **lanatum** (Brand) Jepson.
E. californicum subsp. *australis* var. *lanatum* Brand, Pflanzenreich 4(251): 142. 1913.
"Zwischen Campo und Jacumba", *Abrams 3632.*

Eutoca speciosa Nuttall, Jour. Acad. Phila. ser. 2. 1:158. 1848.
"Near St. Diego", *Nuttall,* 1836.

Nemophila rotata Eastwood, Bull. Torrey Club 28: 159. 1901.
"Near San Diego", *Eastwood,* February 28, 1891. Of the two collections cited by Eastwood, this one, according to Hoover (in Jepson 1943, p. 230), should be considered the type.

Phacelia Aldersonii Greene, Pittonia 5: 22. 1902.
"Witch Creek", *Alderson,* 1893.

Phacelia californica var. **patula** (Brand) Jepson.
P. magellanica forma *patula* Brand, Univ. Calif. Publ. Bot. 4: 219. 1912.
"Stonewall mine, 4,600 ft. alt. in the Cuyamaca Mts.", *S. B. Parish 4423.*

Phacelia eremica Jepson, Man. Fl. Pl. Calif. 823. 1925.
"Rocky cañon walls, . . . Collins Valley", *Jepson 8852.*

Phacelia leucantha Lemmon ex Greene, Pittonia 1: 175. 1888.
"Del Mar", *Mr. and Mrs. Lemmon,* April 1888.

Phacelia Parryi Torrey, Bot. Mex. Bound. 144. 1859.
"Mountains east of San Diego", *Parry,* June 1850.

Phacelia polystachya Greene, Pittonia 5: 19. 1902.
"Witch Creek", *Alderson,* 1893.

Phacelia whitlavia var. **Jonesii** forma **gracillima** Brand, Pflanzenreich 4(251): 71. 1913.
"Fallbrook", *Jones 3099.*

Pholistoma racemosum (Nuttall) Constance.
Nemophila racemosa Nuttall ex A. Gray, Proc. Am. Acad. 10: 315. 1875.
"San Diego", *Nuttall,* 1836.

BORAGINACEAE*

Allocarya echinacea Piper, Contr. U. S. Nat. Herb. 22: 88. 1920.

"University Heights, San Diego", *T. S. Brandegee,* April 12, 1902 (*Baker 825*).

Allocarya inornata Piper, Contr. U. S. Nat. Herb. 22: 106. 1920.

"Ramona", *T. S. Brandegee,* May 23, 1903 (*Baker 3380*).

Amsinckia albicarpa Suksdorf, Werdenda 1: 90. 1931.

"Colorado Desert", *Spencer 251a,* May 30, 1917.

Amsinckia angustata Suksdorf, Werdenda 1: 83. 1931.

"Cottonwood Valley", *Orcutt 3263,* April 5, 1889. Although several other localities were given, this one, cited first, is the type locality according to Jepson (1943, p. 325).

Amsinckia caduca Suksdorf, Werdenda 1: 79. 1931.

"San Diego", *T. S. Brandegee,* March 10, 1903.

Amsinckia curvata Suksdorf, Werdenda 1: 83. 1931.

"Warrens Campo", *Eastwood 9419,* April 22, 1920. Several other localities also were cited, but according to Jepson (1943, p. 325) this one, cited first, is the type locality.

Amsinckia decumbens Suksdorf, Werdenda 1: 86. 1931.

"Grassy places in park, San Diego", *Spencer 169,* February 22, 1916.

Amsinckia deltoidea Suksdorf, Werdenda 1: 110. 1931.

"Between Jacumba and Mountain Springs", *Eastwood 9520,* April 24, 1920. Although other localities were cited, this one is the type locality according to Jepson (1943, p. 322).

Amsinckia diversifolia Suksdorf, Werdenda 1: 79. 1931.

"La Jolla", *F. E. and E. S. Clements,* March 1, 1914; *"San Diego", Jepson 6666.*

Amsinckia Jonesii Suksdorf, Werdenda 1: 69. 1931.

"Fall Brook", *Jones 3112,* March 25, 1882.

Amsinckia laxa Suksdorf, Werdenda 1: 87. 1931.

"Lakeside", *K. Brandegee,* June 1906; also Temescal Canyon, Riverside County.

Amsinckia littoralis Greene ex Suksdorf, Werdenda 1: 99. 1931.

"Peninsula of San Diego", *Greene,* April 10, 1885.

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*Suksdorf's many segregates in *Amsinckia* have generally been reduced to synonymy. See Jepson 1943, p. 318, and Abrams 1951, p. 607.

Amsinckia Palmeri Suksdorf, Werdenda 1: 65. 1931.
"Southern part of San Diego County", *Palmer,* 1875.

Amsinckia Spencerae Suksdorf, Werdenda 1: 86. 1931.
"Colorado Desert", *Spencer 251a* in part, May 30, 1917.

Cryptantha Clevelandii Greene, Pittonia 1: 117. 1887.
"Shaded places along streamlets in the hills back of San Diego", *Cleveland and Greene,* April 1885.

Cryptantha Clevelandii var. **florosa** Johnston, Contr. Gray Herb. ser. 2. 74: 95. 1925.
"Roadside, Linda Vista", *Macbride and Payson 797.*

Cryptantha costata Brandegee, Bot. Gaz. 27: 453. 1899.
"Borregos Springs, Colorado desert", *T. S. Brandegee,* April 18, 1895.

Cryptantha Ganderi Johnston, Jour. Arnold Arb. 20: 386. 1939.
"Near school at Borego Valley, Larrea-Franseria association, 500 ft. alt.", *Gander 5328,* April 15, 1938.

Cryptantha micrantha var. **lepida** (A. Gray) Johnston.
Eritrichium micranthum var. *lepidum* A. Gray, Syn. Fl. N. Am. 2: 193. 1878.
"San Diego Co.", *Cleveland,* 1876. Probably from the Laguna or Cuyamaca Mountains according to Abrams (1951, p. 578).

Pectocarya setosa var. **aptera** Johnston, Contr. Gray Herb. ser. 2. 70: 38. 1924.
"Dry canyon floor near Campo", *Abrams 3571,* 1903.

Plagiobothrys allocaryoides Brand, Repert. Sp. Nov. 20: 47. 1924.
"San Diego", *Jones 3072.*

Plagiobothrys californicus var. **gracilis** Johnston, Contr. Gray Herb. ser. 2. 68: 73. 1923.
"San Diego", *T. S. Brandegee 1658.*

VERBENACEAE

Verbena Abramsii Moldenke, Am. Midl. Nat. 24: 750. 1940.
"Hot Springs, in the southern part of San Diego Co.", *Palmer 309,* 1875.

LABIATAE

Acanthomintha ilicifolia A. Gray.
Calamintha ilicifolia A. Gray, Proc. Am. Acad. 8: 368. 1872.
"California, probably Lower California", *Rich.* According to Abrams (1951, p. 635) the type locality is San Diego.

Lepechinia Ganderi Epling, Brittonia 6: 363. 1948.
"Otay Mountain, 3000 feet", *Epling, Robison, and Gander.*

Monardella lanata Abrams, Muhlenbergia 8: 39. 1912.
"Descanso grade, near the top, Cuiamaca mountains", *K. Brandegee,* July 19, 1906.

Monardella lanceolata var. **microcephala** A. Gray, Syn. Fl. N. Am. ed. 2. 2: 459. 1886.
"Potrero", *Orcutt.*

Monardella linoides A. Gray, Proc. Am. Acad. 11: 101. 1876.
"Mountains east of San Diego", *Palmer,* 1875.

Monardella linoides var. **viminea** (Greene) Munz.
M. viminea Greene, Pittonia 5: 85. 1902.
"Mountains of San Diego Co.", *Vasey,* 1880.

Monardella macrantha A. Gray, Proc. Am. Acad. 11: 100. 1876.
"Cuiamaca Mountains and near Julian City", *Cleveland, Palmer.* According to Jepson (1943, p. 433) the type is *Palmer 295* from the Cuyamaca Mountains.

Monardella macrantha var. **Hallii** Abrams, Muhlenbergia 8: 29. 1912.
"Palomar mountain", *Hall 1936,* May 1901.

Monardella nana A. Gray, Proc. Am. Acad. 11: 101. 1876.
"Mountains behind San Diego", *Cleveland.* Near Talley's according to Abrams (1951, p. 650).

Monardella nana subsp. **leptosiphon** Abrams.
Monardella villosa var. *leptosiphon* Torrey, Bot. Mex. Bound. 129. 1859.
"San Felipe", *Parry,* June 1850. According to Abrams (1951, p. 650) the type probably is from the mountains west of San Felipe canyon along the old San Diego to Fort Yuma road.

Monardella sanguinea Greene, Pittonia 5: 86. 1902.
"Near Julian", *Dunn,* 1881 and 1888.

Pogogyne Abramsii J. T. Howell, Proc. Calif. Acad. ser. 4. 20: 119. 1931.
"Mesa north of San Diego", *Abrams 3446.*

Pogogyne nudiuscula A. Gray, Bot. Calif. 1: 597. 1876.
"Near San Diego", *Cleveland.*

Salvia Clevelandii (A. Gray) Greene.
Audibertia Clevelandii A. Gray, Proc. Am. Acad. 10: 76. 1874.
"Mountains behind San Diego, California, at the elevation of about 2,200 feet", *Cleveland.* Near Potrero according to Epling (1938, p. 119).

Salvia eremostachya Jepson, Man. Fl. Pl. Calif. 870. 1925.
"Indian Cañon, Collins Valley", *Jepson 8847.*

Salvia Palmeri (A. Gray) Greene.
Audibertia Palmeri A. Gray, Bot. Calif. 1: 601. 1876.
"Near Tighes Ranch in the mountains northeast of San Diego", *Palmer,* July 1875.

Salvia Vaseyi (Porter) Parish.
Audibertia Vaseyi Porter, Bot. Gaz. 6: 207. 1881.
"Mountain Springs", *Vasey 500,* June 1880.

Satureja Chandleri (T. S. Brandegee) Jepson.
Calamintha Chandleri T. S. Brandegee, Zoe 5: 195. 1905.
"Mount San Miguel", *Chandler,* May 21, 1904.

Scutellaria Bolanderi subsp. **austromontana** Epling, Madroño 5: 58. 1939.
"Ad rivulum Carrizo dictum prope Lake Henshaw", *Gander 2739,* July 10, 1936.

Scutellaria linearifolia Eastwood, Bull. Torrey Club 30: 493. 1903.
"San Diego", *Fisher 586,* June 1876.

Trichostema Parishii Vasey, Bot. Gaz. 6: 173. 1881.
"San Diego County", *Parish and Vasey.*

SOLANACEAE

Lycium californicum Nuttall ex A. Gray, Bot. Calif. 1: 542. 1876.
"Near San Diego, on clay-hill slopes", *Nuttall,* 1836; also *Cooper, Cleveland.*

Nicotiana Clevelandii A. Gray, Syn. Fl. N. Am. 2: 242. 1878.
"In dry bed of streams, Chollas Valley near San Diego", *Cleveland;* also *Palmer 267,* 1875.

SCROPHULARIACEAE

Antirrhinum Coulterianum subsp. **Orcuttianum** (A. Gray) Pennell.
A. Orcuttianum A. Gray, Bot. Gaz. 9: 54. 1884.
"Near San Diego, and also in adjacent parts of Lower California", *Orcutt.*

Antirrhinum Nuttallianum Bentham in DeCandolle, Prod. 10: 592. 1848.
"S. Diego", *Nuttall,* 1836.

Castilleja oblongifolia A. Gray, Syn. Fl. N. Am. 2: 296. 1878.
"Southern borders of San Diego Co.", *Palmer.*

Collinsia concolor Greene, Erythea 3: 49. 1895.

"Presumably from the southern part of San Diego Co.", *'R. D. Anlerson'*. The collector's name doubtless is a misprint for that of R. D. Alderson, many of whose collections from San Diego County were described by Greene.

Cordylanthus filifolius Nuttall ex Bentham in DeCandolle, Prod. 10: 597. 1846.

"San Diego", *Nuttall*, 1836.

Cordylanthus maritimus Nuttall ex Bentham in DeCandolle, Prod. 10: 598. 1846.

"San Diego", *Nuttall*, 1836.

Mimulus aridus (Abrams) Grant.
Diplacus aridus Abrams, Bull. Torrey Club 32: 540. 1905.

"Dry rocky ridges at Jacumba, near the boundary monument", *Abrams 3656*, May 31, 1903.

Mimulus Clevelandii Brandegee, Gard. & For. 8: 134. 1895.

"South side of Cuyamaca Peak . . . not far from the signal station on its summit", *T. S. Brandegee*, July 7, 1894.

Mimulus diffusus Grant, Ann. Missouri Bot. Gard. 11: 254. 1924.

"Palomar", *Jepson and Hall 1959*, May 29, 1901.

Mimulus Grantianus Eastwood, Proc. Calif. Acad. ser. 4. 20: 153. 1931.

"Campo . . . in sandy soil amid the brush", *Eastwood 9442*, April 23, 1920.

Mimulus latidens (A. Gray) Greene.
M. inconspicuus var. *latidens* A. Gray, Syn. Fl. N. Am. ed. 2. 2: 450. 1886.

"Flanks of Monte Diable", *Brewer, Greene;* "Chollas Valley", *Orcutt 1179*, June 20, 1884. According to Grant (1925, p. 202) the Brewer specimen is the type; but according to Abrams (1951, p. 704) the Orcutt specimen is the type.

Mimulus paniculatus Greene, Leafl. Bot. Obs. 1: 190. 1906.

"Witch Creek", *Alderson*, May 1894.

Mimulus puniceus (Nuttall) Steudel.
Diplacus puniceus Nuttall, Bot. Mag. 65: pl. 3655. 1838.

"Sandy loam by the borders of small winter streams . . . near St. Diego", *Nuttall*, 1836.

Orthocarpus falcatus Eastwood, Bull. Torrey Club 32: 212. 1905.

"Smith or Palomar Mountain, at an elevation of 1500-1800 meters", *S. B. Parish*, June 1-4, 1891.

Penstemon Bridgesii ×**heterophyllus** Hall, Univ. Calif. Publ. Bot. 6: 169. 1915.

"Vicinity of Nellie, a stage station on Palomar Mountain", *Valentien,* July 15, 1910.

Penstemon spectabilis Thurber ex A. Gray, Pacif. Railr. Rep. 4: 119. 1856.

"San Pasqual", *Thurber,* according to Keck (Abrams 1951, p. 756).

Penstemon ternatus Torrey ex A. Gray, Bot. Mex. Bound. 115. 1859.

"Mountains east of San Diego", *Parry.*

PLANTAGINACEAE

Plantago obversa Morris, Bull. Torrey Club 28: 121. 1901.

"Del Mar", *Angier 21,* May 1894.

RUBIACEAE

Galium angustifolium Nuttall ex Torrey & Gray, Fl. N. Am. 2: 22. 1841.

"St. Diego", *Nuttall,* 1836.

Galium angustifolium var. **siccatum** (Wright) Hilend & Howell.
G. siccatum Wright, Zoe 5: 54. 1900.

"Del Mar", *T. S. Brandegee;* also other localities. According to Hilend and Howell (1935, p. 155) Del Mar is the type locality.

Galium Nuttallii A. Gray.
G. suffruticosum Nuttall in Torrey & Gray, Fl. N. Am. 2: 21. 1841.

"St. Diego", *Nuttall,* 1836.

CAPRIFOLIACEAE

Lonicera subspicata var. **denudata** Rehder, Missouri Bot. Gard. Rep. 14: 176. 1903.

"San Diego", *Thurber 558,* May 1852; *Cleveland,* 1874; *Palmer 120,* 1875; *Orcutt,* June 20, 1884; also Santo Tomas hills, Baja California, Mexico. According to McMinn (1951, p. 543) Thurber's specimen is the type.

VALERIANACEAE

Aligera patelliformis Suksdorf, West Am. Sci. 12: 53. 1901.

"Auf feuchten oder nassen Plätzen, Stonewall Mine, Cuyamaca-Gebirg, Meereshöhe 4600 F.", *Parish 4539,* June 1897.

CUCURBITACEAE

Cucurbita palmata S. Watson, Proc. Am. Acad. 11: 137. 1876.
"Cajon Valley", *Cleveland;* "Larkin's Station near the Jacumba Mountains", *Palmer,* August 1875.

CAMPANULACEAE

Githopsis filicaulis Ewan, Rhodora 41: 312. 1939.
"Mission Canyon, San Diego", *Orcutt,* May 8, 1884.

Githopsis specularioides subsp. **candida** Ewan, Rhodora 41: 308. 1939.
"Gravelly burn in chaparral, 6 mi. n. of Santa Ysabel", *Munz 9806,* May 19, 1925.

LOBELIACEAE

Downingia concolor var. **brevior** McVaugh, Mem. Torrey Club 19: 20. 1941.
"Cuyamaca Lake", *Abrams 3851.*

Downingia pulchella var. **arcana** Jepson, Madroño 1: 100. 1922.
"La Mesa", *Jepson 6678.*

Nemacladus glanduliferus Jepson, Man. Fl. Pl. Calif. 975. 1925.
"Wagon Wash, near Sentenac Cañon", *Jepson 8766.*

Nemacladus ramosissimus Nuttall, Trans. Am. Philos. Soc. ser. 2. 8: 254. 1842.
"In sandy soils, near St. Diego", *Nuttall,* 1836.

COMPOSITAE

Achillea californica Pollard, Bull. Torrey Club 26: 369. 1899.
"Sea coast at Santa Ysabel", *Henshaw,* May 1893.

Ambrosia pumila (Nuttall) A. Gray.
Franseria pumila Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 344. 1841.
"Near St. Diego", *Nuttall,* 1836.

Aromia tenuifolia Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 396. 1841.
"Near the coast of St. Diego", *Nuttall,* May 1836.

Artemisia Palmeri A. Gray, Proc. Am. Acad. 11: 79. 1876.
"Jamuel Valley", *Palmer,* June 1875.

Aster Orcuttii Vasey & Rose, Bot. Gaz. 16: 113. 1891.
"Cariso Creek Wash", *Orcutt.*

Baccharis sorothroides A. Gray, Proc. Am. Acad. 17: 211. 1882.

"Southern borders of California, San Diego Co., near the old Mission station, the boundary monument, &c.", *Hayes, Palmer.*

Baeria aristata (Nuttall) Coville.
Ptilomeris aristata Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 382. 1841.

"Near St. Diego", *Nuttall,* April 1836.

Baeria chrysostoma var. **gracilis** forma **crassa** Hall, Univ. Calif. Publ. Bot. 3: 172. 1907.

"Ocean Beach", *K. Brandegee,* May 1906.

Baeria Clevelandii A. Gray, Proc. Am. Acad. 19: 22. 1883.

"Near San Diego", *Cleveland,* 1874.

Bidens californica Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 368. 1841.

"St. Diego and St. Barbara", *Nuttall,* 1836; also Chile.

Brickellia arguta var. **odontolepis** Robinson, Mem. Gray Herb. 1: 103. 1917.

"In desertis Colorado nominatis", *Orcutt,* 1889.

Brickellia frutescens A. Gray, Proc. Am. Acad. 17: 207. 1882.

"Mountain Springs", *Vasey,* 1880.

Calais Parryi A. Gray, Pacif. Railr. Rep. 4: 112. 1857.

"Near San Diego", *Parry.*

Calycoseris Wrightii var. **californica** Brandegee, Zoe 5: 155. 1903.

"In sand, near San Felipe", *T. S. Brandegee.*

Chaenactis glabriuscula var. **tenuifolia** (Nuttall) Hall.
C. tenuifolia Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 375. 1841.

"St. Diego", *Nuttall,* May 1836.

Chaenactis latifolia Stockwell, Contr. Dudley Herb. 3: 128. 1940.

"Jacumba Springs", *Eggleston 19747.*

Chaenactis Peirsonii Jepson, Madroño 1: 259. 1929.

"Silent Cañon, in the desert foothills, southeast end of the Santa Rosa Mountains", *Jepson 11708,* April 14, 1927.

Chaenactis tenuifolia var. **Orcuttiana** Greene, West Am. Sci. 3: 157. 1887.

"Along the beaches about San Diego", *Orcutt, Cleveland, Parry,* and others.

Coreopsis californica (Nuttall) H. Sharsmith.
Leptosyne californica Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 363. 1841.

"Near St. Diego", *Nuttall,* May 1836.

Coreopsis maritima (Nuttall) Hooker f.
Tuckermannia maritima Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 363. 1841.
"On shelving rocks, near the sea, at St. Diego", *Nuttall,* 1836.

Corethrogyne brevicula Greene, Leafl. Bot. Obs. 2: 26. 1910.
"Mountains of San Diego Co.", *Orcutt,* October 1899.

Corethrogyne filaginifolia var. **linifolia** Hall, Univ. Calif. Publ. Bot. 3: 71. 1907.
"About one kilometer south of Del Mar . . . in hard siliceous soil on an exposed windswept bluff overlooking the sea", *K. Brandegee,* August 5, 1906.

Corethrogyne filaginifolia var. **pacifica** Hall, Univ. Calif. Publ. Bot. 3: 73. 1907.
"Pacific Beach . . . just back from the beach . . . in rich, loose soil along a railroad embankment", *Purpus,* summer of 1899.

Corethrogyne incana Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 290. 1841.
"Near St. Diego", *Nuttall,* May 1836.

Corethrogyne racemosa Greene, Leafl. Bot. Obs. 2: 26. 1910.
"Mountains of San Diego Co.", *Orcutt,* 1899.

Dysodia porophylloides A. Gray, Mem. Am. Acad. ser. 2. 5: 322. 1855.
"Sandy hills, near San Felipe", *Thurber,* May 1852.

Encelia farinosa A. Gray ex Torrey in Emory, Notes Mil. Rec. 143. 1848.
Although the locality of collection was not definitely stated, this species was mentioned in the narrative (p. 103) under the date of November 28 and 29, 1846, when the party was in the vicinity of "Cariso (cane) creek". This locality was therefore taken by Abrams (1910, p. 480) as the type locality.

Eriophyllum Wallacei var. **rubellum** (A. Gray) Jepson.
Bahia rubella A. Gray, Bot. Mex. Bound. 95. 1859.
"In a dry valley, near San Felipe", *Parry,* June 1850.

Franseria Palmeri Rydberg, N. Am. Fl. 33: 25. 1922.
"San Diego", *Palmer,* 1875.

Geraea viscida (A. Gray) Blake.
Encelia viscida A. Gray, Proc. Am. Acad. 11: 78. 1876.
"Near Larkens' Station", *Palmer,* August 1875.

Gnaphalium bicolor Bioletti, Erythea 1: 16. 1893.
"Common in low thickets among the coast hills about San Diego", *Greene?*

Gnaphalium microcephalum Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 404. 1841.
"St. Diego", *Nuttall,* May 1836.

Grindelia Hallii Steyermark, Ann. Missouri Bot. Gard. 21: 229. 1934.
"Open meadows about Cuyamaca Lake", *Abrams 3957,* June 30, 1903.

Haplopappus junceus Greene, Bull. Calif. Acad. 1: 190. 1885.
"San Diego County", *Cleveland, Curran;* also Baja California, Mexico.

Haplopappus propinquus Blake.
Bigelovia brachylepis A. Gray, Bot. Calif. 1: 614. 1876.
"Larkens' Station", *Palmer,* August 1875.

Haplopappus venetus var. **decumbens** (Greene) Munz.
Isocoma decumbens Greene, Leafl. Bot. Obs. 1: 172. 1906.
Greene gave no locality, but he cited only one specimen, C. F. Baker's *3405,* collected by T. S. Brandegee. According to Hall (1928, p. 227) this came from clay depressions on the mesas near San Diego.

Haplopappus venetus var. **oxyphyllus** (Greene) Munz.
Isocoma oxyphylla Greene, Leafl. Bot. Obs. 1: 171. 1906.
"Jamul Valley", *Palmer,* June 1875.

Helianthus gracilentus A. Gray, Proc. Am. Acad. 11: 77. 1876.
"In the mountains 45 miles north-east of San Diego", *Palmer.*

Hemizonia conjugens Keck, Aliso 4: 109. 1958.
"River-bottom land near Otay", *Abrams 3521,* May 16, 1903.

Hemizonia fasciculata var. **ramosissima** (Bentham) A. Gray.
H. ramosissima Bentham, Bot. Voy. Sulphur 30. 1844.
"San Diego", *Hinds,* October 1839.

Hemizonia floribunda A. Gray, Proc. Am. Acad. 11: 79. 1876.
"California, near the southern boundary, on the Fort Yuma Road, 80 miles east of San Diego", *Palmer.*

Hemizonia tenella (Nuttall) A. Gray.
Osmadenia tenella Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 392. 1841.
"St. Diego", *Nuttall,* May 1836.

Holocarpha virgata subsp. **elongata** Keck, Aliso 4: 111. 1958.
"San Diego", *Keck 1932,* October 2, 1932.

Hulsea californica Torrey & Gray, Bot. Mex. Bound. 98. 1859.
"Mountains east of San Diego . . . in bushy places", *Parry,* June 1850.

Hymenopappus wrightii var. **viscidulus** Jepson, Man. Fl. Pl. Calif. 1128. 1925.
"Cuyamaca Mts.", *T. S. Brandegee.*

Isocoma leucanthemifolia Greene, Leafl. Bot. Obs. 1: 171. 1906.

"Warren, in the Mountains of San Diego Co.", *Orcutt,* October 21, 1889. According to Hall (1928, p. 227) the type is from Warner's Ranch.

Iva Hayesiana A. Gray, Proc. Am. Acad. 11: 78. 1876.

"Jamuel Valley", *Palmer,* June 1875. Gray also cited a specimen collected by Hayes at Warners Pass in 1858, but he said that it was indeterminable, the heads having all fallen from their peduncles.

Machaeranthera hiemalis A. Nelson, Am. Jour. Bot. 21: 580. 1934.

"Devil's Canyon, near Jacumba", *Nelson 11190,* March 14, 1930.

Machaeranthera lagunensis Keck, Brittonia 9: 238. 1957.

"From 2 miles south of the main recreation area in the Laguna Mountains . . . at 5200 ft. elevation . . . on dry slopes under pines", *Munz and Balls 17948,* August 20, 1952.

Madraglossa carnosa Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 393. 1841.

"St. Diego . . . growing in the sands of the sea-coast", *Nuttall,* 1836.

Malacothrix Clevelandii A. Gray, Bot. Calif. 1: 433. 1876.

"Near San Diego", *Cleveland;* also Baja California.

Microseris breviseta Greene, Pittonia 5: 8. 1902.

"San Diego", *Greene,* April 1885.

Microseris heterocarpa (Nuttall) K. Chambers.
Uropappus heterocarpus Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 425. 1841.

"St. Diego", *Nuttall,* 1836.

Microseris Parishii Greene, Bull. Calif. Acad. 2: 46. 1886.

"Near San Luis Rey", *S. B. and W. F. Parish 955,* April 1881; "near San Diego". *Greene,* 1885; also near Tulare. According to Chambers (1955, p. 291) the Parish specimen is the type.

Microseris platycarpha A. Gray.
Calais platycarpha A. Gray, Pacif. Railr. Rep. 4: 113. 1857.

"San Luis Rey", *Parry,* 1850.

Pentachaeta aurea Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 336. 1841.

"In dry plains near the sea, in the vicinity of St. Diego", *Nuttall,* April 1836.

Perityle Emoryi Torrey in Emory, Notes Mil. Rec. 142. 1848.

"Cordilleras of California", *Emory,* 1846.

Porophyllum caesium Greene, Leafl. Bot. Obs. 2: 155. 1911.

"Cajon Hills", *Dunn,* May 1, 1891.

Porophyllum Vaseyi Greene, Leafl. Bot. Obs. 2: 154. 1911.
"Mountain Springs", *Vasey*, 1880.

Ptilomeris anthemoides Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 382. 1841.
"Near St. Diego", *Nuttall*, 1836.

Ptilomeris coronaria Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 382. 1841.
"Near St. Diego", *Nuttall*, 1836.

Ptilomeris mutica Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 382. 1841.
"Near St. Diego", *Nuttall*, 1836.

Rafinesquia californica Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 429. 1841.
"Near the sea-coast, in the vicinity of St. Diego", *Nuttall*, 1836.

Solidago confinis A. Gray, Proc. Am. Acad. 17: 191. 1882.
"Southern borders of California", *Palmer, Cleveland, Parish.*

Sonchus fallax? var. **californicus** Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 438. 1841.
"Around St. Diego", *Nuttall*, 1836.

Sonchus tenuifolius Nuttall, Trans. Am. Philos. Soc. ser. 2. 7: 438. 1841.
"Round St. Diego, in shady ravines, among rocks", *Nuttall*, 1836.

Stephanomeria exigua var. **deanei** Macbride, Contr. Gray Herb. 53: 22. 1918.
"Sweetwater Valley", *Deane*, July 23, 1888.

Viguiera deltoidea var. **Parishii** (Greene) Vasey & Rose.
V. Parishii Greene, Bull. Torrey Club 9: 15. 1882.
"San Luis Rey", *S. B. and W. F. Parish 963*, April 1881.

Viguiera laciniata A. Gray, Bot. Mex. Bound. 89. 1859.
"Rancho Gamacha [=Jamacha]", *Schott*, September 1855.

Wyethia coriacea A. Gray, Proc. Am. Acad. 11: 77. 1876.
"On the Mesa Grande, 70 miles north-east of San Diego", *Palmer*, July 1875.

Wyethia ovata Torrey & Gray in Emory, Notes Mil. Rec. 143. 1848.
"Western side of the Cordilleras of California", *Emory*, December 4, 1846. According to Abrams (1905, p. 541) the specimens evidently were collected between Warners Ranch and Santa Isabel.

NOTES CONCERNING THE COLLECTORS

An attempt is made to identify all those mentioned in the Systematic List as collectors of type specimens in San Diego County. Recent and well-known collectors are briefly noted, with references to published biographical material when known. Information about most current and recent professional botanists also may be found in *American Men of Science* (Cattell 1955 and earlier editions), though it has not seemed necessary to repeat this reference for each individual. A special effort has been made to learn about the earlier and more obscure collectors and their botanical work in the County.

ABRAMS, LEROY (1874-1956)

Dr. Abrams was professor of biology at Stanford University and an authority on the flora of the western United States. In the spring and summer of 1903 he collected extensively in San Diego County in connection with his doctoral problem (Abrams 1910). For a portrait and brief tribute, see Bacigalupi and Mason (1954), and for a sketch of his life and work, see Wiggins (1957).

ADAMS, JOSEPH EDISON (1903-)

Dr. Adams is professor of botany at the University of North Carolina. For a doctoral thesis at the University of California, under Professor Jepson, he wrote a revision of *Arctostaphylos*.

ALDERSON, RUFUS DAVIS (1858-1932)

Mr. Alderson was a newspaperman and teacher who came to California in 1884 or soon after and returned to his native West Virginia in 1897. Between 1889 and 1897 he taught school in San Diego County, his posts including Potrero, Descanso, El Nido, Warner, Glencoe, Santa Ysabel, Spring Hill, and Witch Creek. From 1893 to 1896 he collected some thousands of botanical specimens in various parts of the County but especially about Witch Creek. He sent many duplicates for identification to E. L. Greene and to S. B. Parish. Other duplicates he sold or exchanged.

ANGIER, BELLE SUMNER (Mrs. WALTER L. BURN) (1870-1948)

Mrs. Burn's interest was primarily horticultural, but she collected botanical specimens for her cousin Professor C. S. Sargent. At his instance and under his direction, she propagated seedlings of the Torrey Pine which were distributed by him. She wrote for the papers, urging the preservation of the Torrey Pine, and thus helped initiate the interest leading to the ultimate establishment of the Torrey Pines Preserve.

ANTISELL, THOMAS (1817-1893)

Dr. Antisell was geologist on the Pacific Railroad Survey under Lt. J. G. Parke from 1854 to 1856. The party reached San Diego from central California in April 1855, and in May they started for Arizona. For a portrait and biographical sketch, see Merrill (1906).

BAKER, CHARLES [or CARL] FULLER (1872-1927)

Professor Baker was an untiring and intensive collector, both botanical and entomological. He was at Pomona College for several years (1903-1904, 1908-1912) as assistant professor and professor. There he was especially active in entomology, though his botanical collections also were very rich. From Pomona he went to the Philippines, where he remained until his death. For an account of his life, see Essig (1927).

BALLS, EDWARD KENT (1892-)

Mr. Balls is horticulturist at the Rancho Santa Ana Botanic Garden and a botanical collector of worldwide experience.

BARCLAY, GEORGE

Mr. Barclay was a botanical collector sent on the voyage of H. M. S. *Sulphur* to obtain plants and seeds for "his Majesty's garden at Kew". See under HINDS.

BESTOR, NORMAN

Mr. Bestor was botanical collector on the expedition of the Army of the West in 1846. See under EMORY. As remarked by Ewan (1950, p. 163), Lt. Emory has always received credit for the collections.

BOLANDER, HENRY N[ICHOLAS] (1831-1897)

Dr. Bolander was state botanist of California, succeeding William Brewer in 1864. In 1871 he became state superintendent of schools, and in this capacity he was able to visit every section of the state. In 1873 he visited San Diego, the Cuyamaca Mountains, and the desert at San Felipe. A tribute was paid him by Jepson (1898).

BRANDEGEE, [MARY] KATHARINE [LAYNE] [CURRAN] (1844-1920)
BRANDEGEE, T[OWNSHEND] S[TITH] (1843-1925)

During his earlier years while employed as a civil engineer, Mr. Brandegee had a lively interest in botany, which later crystallized as a life-time career. Mrs. Brandegee was curator of botany in the California Academy of Sciences from 1883 until 1894. In 1894 the Brandegees moved to San Diego, where they lived until 1906. In this period they collected widely throughout the County and beyond. In 1906 they moved to Berkeley, where they staid until their deaths. An account of the lives of these two botanists with complete bibliography was given by Setchell (1926).

BULLARD, FRANCES E. (? -1932)

Mrs. Bullard (neé Schmidt) was the wife of Dr. J. H. Bullard, a friend of Dr. Anstruther Davidson, Los Angeles botanist. On trips with her husband, Mrs. Bullard collected for Dr. Davidson, who described her findings in the Bulletin of the Southern California Academy of Sciences. An ardent horticulturist, she was the originator of many hybrid Watsonias, put on the market for her by Theodore Payne. For notes concerning her, see Payne (1954).

Burbeck, Anna Leora (1861-1935)

Miss Burbeck, a native of Sherborn, Massachusetts, came to National City in 1871. Like her friend Miss Kimball, q.v., she collected and pressed native ferns. She also made some 150 water-color paintings of wild flowers. In 1887 she married Albert Carleton Copeland.

Chandler, H[arley] P[ierce] (1875-1918)

Mr. Chandler was a teacher with a strong avocational interest in botany. From 1904 to 1905 he was principal of Russ High School in San Diego, and while here he collected extensively in the County. For a biographical sketch, with portrait, see Jepson (1929b).

Clements, Frederick E[dward] (1874-1945)
Clements, Edith [Gertrude] S[chwartz] (1877-)

Dr. Frederick Clements, the well-known ecologist, was Professor of Botany at the University of Nebraska and the University of Minnesota. From 1917 until his retirement in 1941 he was research associate in ecology with the Carnegie Institution of Washington. For accounts of his life, with portraits and bibliography, see Shantz (1945) and Pool (1954). Dr. Edith Clements was her husband's assistant and botanical illustrator. She now lives in La Jolla.

Cleveland, Daniel (1838-1929)

Daniel Cleveland came to San Diego in 1869 and remained for the rest of his life. Actively engaged in the practice of law, he made the study of botany his lifelong avocation. He collected widely in the County; and his collections, sent to Asa Grey, Sereno Watson, and Edward Lee Greene, became the basis for several new species. He was a charter member of the San Diego Society of Natural History and its president from 1888 to 1890 and in 1893 and 1894. The Society inherited the Cleveland collection, an herbarium of some 3000 specimens. For a biographical sketch, with portrait, see Jepson (1929a). Further details of his life may be found in the San Diego Union, January 4, 1929.

Cooper, James Graham (1830-1902)

Dr. Cooper, after whom the Cooper Ornithological Club was named, is best known for his pioneer work in western ornithology and mammalogy. However, he was very active in other branches of natural history, including botany. He wrote on the vegetation of the Cuyamaca Mountains (1874). For details of his life, see Emerson (1898, 1902), Taylor (1919), and Grinnell (1930).

Coulter, Thomas (1793-1843)

Dr. Coulter, an Irishman, was a keen botanist and a prodigious collector. In 1832 he travelled overland from Monterey to the Colorado River and back, passing Pala, Warners Pass, and Carrizo, and also making a side trip to San Diego. He was thus the first botanist to cross the Colorado Desert. His types of several desert plants must have been collected on this trip, but it is not known whether they are from San Diego County or from farther east. For notes on his life, and on this trip in particular, see Coville (1895) and Mc Kelvey (1955).

Curran, [Mary] Katharine see Brandegee, Katharine

DEANE, GEORGE CLEMENT (1854-1930)

Mr. Deane, a native of Cambridge, Massachusetts, came to California with a partner in the late 1870's and started a vineyard at Bonita, in the Sweetwater Valley. Most of his later life was spent in Cambridge, but he returned twice to California. Though primarily interested in birds, he collected many botanical specimens for his brother Walter Deane, a New England botanist. For a biographical note, see Allen (1930).

DUNN, G[EORGE] W[ASHINGTON] (1814-1905)

Mr. Dunn was a professional collector of natural history materials, including plants. He is said to have lived in San Diego for many years. A record of his activities, with a portrait, was given by Jepson (1934d).

EASTWOOD, ALICE (1859-1953)

Miss Eastwood served as curator of botany in the California Academy of Sciences for 57 years, from 1892 to 1949, when at the age of 90 she became curator emeritus. She collected widely, her trips including six to San Diego County (Wilson 1953). Several of her collections became the types of new species. A biographical sketch, with bibliography and portrait, appeared in a volume celebrating her fiftieth year with the California Academy of Sciences (MacFarland et al. 1949). A full biography is by Wilson (1955) and a sketch by Dakin (1954). A tribute to her is from the heart of John Thomas Howell (1954).

EGGELSTON, W[ILLARD] W[EBSTER] (1863-1935)

Mr. Eggelston was botanist with the U. S. Forest Service and Bureau of Plant Industry from 1910 until his retirement in 1933.

EMORY, W[ILLIAM] H[EMSLEY] (1811-1887)

In 1846 Lt. Emory, as topographical engineer, accompanied the Army of the West from Fort Leavenworth to San Diego on a march culminating in the Battle of San Pasqual. Entering what is now San Diego County late in November, they passed Carrizo, Warners Ranch, Santa Ysabel, and the Soledad River, reaching San Diego December 12th. Emory (1848) recounted the details of this memorable expedition, and to his report was appended Dr. Torrey's catalog of the plants collected. See under BESTOR. For further information, see McKelvey (1955). Later Emory was chief astronomer, then commissioner, of the United States and Mexican Boundary Survey. For an account of his life, see Carey (1931).

EPLING, CARL C[LAWSON] (1894-)

Dr. Epling is professor of botany at the University of California at Los Angeles. His specialty is the Labiatae, upon which he has published widely.

EVERETT, PERCY C[HARLES] (1902-)

Mr. Everett is superintendent of the Rancho Santa Ana Botanic Garden.

FISHER, WILLIAM J.

In the San Francisco directory from 1866 to 1880, Mr. Fisher was listed variously as "bookkeeper", "curiosities", and "master mariner", but mostly as "naturalist". In 1876 he was librarian of the California Academy of Sciences.

FORBES, CHARLES N[OYES] (1883-1920)

After high school in National City, San Diego County, Mr. Forbes graduated from the University of California. He became assistant botanist, then curator of botany, at the Bishop Museum, where he remained until his death. For a biographical sketch, see Gregory (1921, p. 9).

FOSBERG, F[RANCIS] RAYMOND (1908-)

Dr. Fosberg is botanist for the U. S. Geological Survey. As an undergraduate at Pomona College and while assistant botanist at the Los Angeles County Museum, he collected extensively in southern California.

FROEBEL, JULIUS (1805-1893)

A political refugee from Germany because of his participation in the Revolution of 1848, Mr. Froebel came to this country and settled near San Francisco in 1854. He became a member of the California Academy of Sciences. For biographical notes, see Ewan (1955, p. 15, 49).

FULTZ, FRANCIS M[ARION] (1857-1948)

Mr. Fultz was a writer, lecturer, and educator, in his later years connected with the city schools in Santa Barbara and Los Angeles. During this period he published several books on plant life, the best known of which is "The Elfin Forest" (Fultz 1920).

GAMBEL, WILLIAM (1821-1849)

Mr. Gambel was a friend and protégé of Thomas Nuttall, who sent him to California to collect natural history specimens. Primarily an ornithologist, he was according to Palmer (1928) the first to spend any length of time in California. His botanical collections, though apparently small, are important. He came overland late in 1841. Details of his itineraries in California and his date of departure are unknown. McKelvey (1955, p. 737) suggested that the San Diego specimens attributed to him possibly were collected by Nuttall. For notes on his travels, see McKelvey (1955).

GANDER, FRANK F[OREST] (1899-)

Mr. Gander was curator of botany in the Natural History Museum, San Diego, from 1934 to 1942. During part of this time he was also supervisor of nature study in the County schools; and while travelling to visit the schools, he collected intensively throughout the County. He now maintains a nursery of native California plants near Escondido.

GENTRY, HOWARD SCOTT (1903-)

Dr. Gentry is botanist with the Section of Plant Introduction of the U. S. Department of Agriculture. He has collected widely in Mexico. He has a special interest in *Agave* and has many plants in cultivation at his ranch home near Temecula.

GIRD, H[ENRY] H[ARRISON] (?1827-1913)

Mr. Gird bought a large ranch near Bonsall in 1876 and moved there in 1880. He had an orchard with many kinds of fruit. For further information about him, see the San Diego Union, September 9, 1939.

GRANT, GEORGE B[ERNARD] (1849-1917)

Mr. Grant was an amateur botanist who lived for some years in Pasadena and collected widely in southern California. His herbarium was given to S. B. Parish and with the Parish herbarium went to Stanford University. For a biographical note, see Ewan (1950, p. 218).

GREENE, EDWARD LEE (1843-1915)

Professor Greene taught at the University of California from 1885 until 1905, when he moved to Washington, D. C. For details of his life and work, see Nieuwland (1915), Bartlett (1916), Jepson (1931), and Ewan (1950). For his bibliography see Kistler (1936).

GRIFFITHS, DAVID (1867-1935)

Dr. Griffiths was an agriculturist and horticulturist with the U. S. Department of Agriculture. He was especially interested in cacti and wrote several articles about them.

HALL, HARVEY M[ONROE] (1874-1932)

Dr. Hall taught botany at the University of California from 1903 until 1919. For the rest of his life he was investigator in experimental taxonomy for the Carnegie Institution of Washington, still working in California. He was a meticulous taxonomist of broad vision, concerned especially with the Compositae. For a biography and bibliography, see Babcock (1934). A story of his life with many interesting details was given by Jaeger (1953).

HAYES, SUTTON (? -1863)

Dr. Hayes was assistant surgeon on the El Paso and Fort Yuma Wagon Road Expedition of 1857 to 1859. *Iva Hayesiana* was named "in memory of the estimable discoverer". He later went to Panama for his health and collected extensively there until his death. For a biographical note, see Seemann (1863).

HENSHAW, HENRY W[ETHERBEE] (1850-1930)

Mr. Henshaw, sometime chief of the U. S. Biological Survey, was primarily an ornithologist; but he also collected in a limited way in other fields, "even plants". He was in southern California in 1892 to 1894, when he visited Frank Stephens at Witch Creek. For a sketch of his life, see Nelson (1932).

HINDS, RICHARD BRINSLEY (?1812-1847)

Dr. Hinds was surgeon-naturalist on the voyage of H. M. S. *Sulphur* around the world in 1835 to 1842. They visited California in 1837 and 1839, stopping in San Diego in October of 1839. Collections were made by Hinds and by Mr. Barclay, a collector from Kew. The botany of the expedition was reported by Bentham (1844-46), with an introduction by Hinds. For an account of the expedition in western North America, see McKelvey (1955).

HITCHCOCK, C[HARLES] LEO (1902-)

Dr. Hitchcock is professor of botany at the University of Washington, Seattle.

HITCHCOCK, GEORGE N. (1843-1907)

Mr. Hitchcock, born in Boston, came to San Diego in 1869. He was a lawyer but was interested in plants. Together with J. C. Parker, a photographer, he followed Parry's notes and collected *Agave Shawii* at the border station. They sent specimens and photographs to Dr. Engelmann at St. Louis. For a biographical note, with portrait, see Black (1913).

HOWELL, JOHN THOMAS (1903-)

Mr. Howell is curator of botany at the California Academy of Sciences and a keen student of the California flora.

HUTCHINGS, JAMES M[ASON] (1818-1902)

Mr. Hutchings was known for his connection with the Yosemite Valley as guide and hotelkeeper, guardian of the state park, and author and lecturer. For details of his career, see Russell (1947).

JENSEN, H[ERBERT] A. (1906-)

Mr. Jensen, who was with the U. S. Forest Service from 1930 to 1948, worked with A. E. Wieslander on the Vegetation Type Map project. He is now a member of the forestry consulting firm of Hammon, Jensen and Wallen, in Oakland, California.

JEPSON, WILLIS LINN (1867-1946)

Dr. Jepson's whole life at the University of California was devoted to the study of California botany. For 60 years, from his student days until his death as Professor Emeritus, it was his only thought. He wrote voluminously on the subject, and to his writings we are much indebted. He collected extensively throughout California but did comparatively little in San Diego County. For a biographical sketch, see Constance (1947); and for an estimate of his place in California botany, see Keck (1948).

JOHNSON, ERNEST R[ALPH] (1890-)

Mr. Johnson was superintendent of the Rancho Santa Ana and was the first superintendent of the Rancho Santa Ana Botanic Garden.

JONES, MARCUS E[UGENE] (1852-1934)

Mr. Jones was an amateur botanist who collected widely in western North America but especially in the Great Basin. He collected comparatively little in San Diego County. Jones (c. 1930) wrote an account of his own botanical activities. Jepson (1934c) gave a pithy commentary on his botanical work. An interesting and more personal account was given by Ewan (1950) and another by Jaeger (1952).

KECK, DAVID D[ANIELS] (1903-)

Dr. Keck is head curator of the New York Botanical Garden. He collected in California while a student and while on the staff of the Stanford laboratory of the Carnegie Institution of Washington.

KESSLER, ROBERT

Mr. Kessler is an amateur horticulturist, formerly of Los Angeles and now of Whittier. Apparently at one time he was interested in growing native plants, and several of these were described as new by Dr. Anstruther Davidson.

KIMBALL, LAURA FRANCES (1856-1942)

Miss Kimball was a resident of National City, San Diego County, from the time of her arrival in California in 1869. An amateur botanist, she was especially interested in ferns.

LEMMON, JOHN GILL (1832-1908)

Mr. Lemmon was a botanist who, together with his wife, Sara Allen Plummer Lemmon, collected widely in California, Nevada, and Arizona. He was botanist to the state forestry board in California during its brief existence from 1888 to 1892. Through his writings he did much to popularize botany and forestry. For a sketch of his life, see Jepson (1933).

MACBRIDE, J[AMES] FRANCIS (1892-)

Mr. Macbride is curator of Peruvian botany for the Chicago Natural History Museum. He lives in California and may be reached through the Dudley Herbarium, Stanford University.

MEARNS, EDGAR A[LEXANDER] (1856-1916)

Dr. Mearns, a surgeon with the U. S. Army, was a prodigious collector of zoological and botanical specimens. From 1891 to 1894, as medical officer for the United States and Mexican Boundary Survey, he was able to explore the boundary from El Paso to the Pacific coast, making large and important collections. For a sketch of his life, see Miller (1933).

MORAN, REID [VENABLE] (1916-)

Dr. Moran is curator of botany at the Natural History Museum, San Diego. His special interest is the Crassulaceae.

MUNZ, PHILLIP A[LEXANDER] (1892-)

Dr. Munz is director of the Rancho Santa Ana Botanic Garden. He is an authority on the flora of California and a special student of the Onagraceae.

NELSON, AVEN (1859-1952)

Dr. Nelson was professor of botany at the University of Wyoming. For a biographical sketch, see Ewan (1950, p. 271). His portrait appears as the frontispiece to volume seven of *Madroño*.

NEWBERRY, JOHN S[TRONG] (1822-1892)

Dr. Newberry was physician and naturalist on Lt. Ives' expedition to explore the Colorado River in 1857 and 1858 (Ives 1861). In November of 1857 he crossed the desert from San Diego to Yuma by way of Santa Ysabel and Warners Ranch. For details of his life, see Merrill (1906, 1934).

NUTTALL, THOMAS (1786-1859)

Of English birth, Mr. Nuttall came in 1807 or 1808 to Philadelphia, where he became affiliated with the Academy of Natural Sciences. In 1834 he journeyed overland with the Wyeth Expedition to Oregon. Thence he sailed by way of the Hawaiian Islands to Monterey and down the coast to San Diego, finally taking passage for Boston on the *Alert*, whose voyage was described by Richard Henry Dana in his well-known *Two years before the*

mast. Dana told of his surprise at finding in San Diego "Professor N_____, of Cambridge, [whom he had] last seen quietly seated in the chair of Botany and Ornithology, in Harvard University". In San Diego from April 15th to May 8th, 1836, Nuttall collected many botanical specimens, seventy-one of which became types. Nuttall's portrait appears as frontispiece to volume two of *Madroño*. For accounts of his western travels, see Jepson (1934b) and McKelvey (1955).

ORCUTT, CHARLES RUSSELL (1864-1929)

Mr. Orcutt was a commercial collector of natural history materials who made his home in San Diego. He was an indefatigable collector and in the course of his work made many discoveries. Also he was the editor and publisher of the *West American Scientist*. An account of his life was given by Jepson (1929c).

PALMER, EDWARD (?1831-1911)

Dr. Palmer was a professional collector whose work was mostly in Mexico, both on the mainland and in Baja California. Over 200 species are said to have been named for him as collector. Although he visited San Diego County several times, his most important collections here, including several types, were in 1875. For details of his life and collections, see McVaugh (1956).

PARISH, SAMUEL BONSALL (1838-1928)

After the Civil War, Mr. Parish and his brother William started west, eventually settling in 1872 in the San Bernardino Valley, where they purchased a ranch. He was an enthusiastic botanical collector for more than forty years, collecting throughout southern California and being the first to explore some areas botanically. A voluminous but careful writer, he added much to the literature of southern California botany. His herbarium was purchased by Stanford University. Jepson (1932) published a record of his botanical activities with a portrait and a full bibliography.

PARISH, WILLIAM FLETCHER

Mr. Parish to some extent shared the botanical interests of his brother Samuel and sometimes collected with him.

PARKER, J. C.

Mr. Parker, a native of Cincinnati, came to San Diego in 1873 and engaged in business as a photographer. He made not only portraits but landscape photographs as well. See under HITCHCOCK, GEORGE N. For a biographical note, see Anonymous (1890).

PARRY, C[HARLES] C[HRISTOPHER] (1823-1890)

Dr. Parry was a physician who served as botanist and geologist with the United States and Mexican Boundary Survey. He arrived in San Diego by sea in July 1849 and collected in southern California until March 1851. In 1875 and later he returned to southern California and collected widely. Preston (1893) published a biographical sketch, to which was appended a bibliography compiled by Mrs. Parry. Tributes to his work were given by Parish (1909a) and Jepson (1934a).

PAYSON, EDWIN BLAKE (1893-1927)

Dr. Payson was at the University of Wyoming, both as an undergraduate and later as a professor of botany. For a biographical sketch, see Ewan (1950, p. 279).

PHILBROOK, MYRTLE (1877-)

Miss Philbrook collected *Ceanothus cyaneus* on her brother's ranch at Lakeside, and she and her brother submitted it to Miss Kate Sessions. Recognizing it as a new species, Miss Sessions sent it to Miss Alice Eastwood, who named it. Miss Philbrook lives in San Diego.

PRINGLE, CYRUS GUERNSEY (1838-1911)

Mr. Pringle was a professional botanical collector best known for his voluminous Mexican collections, distributed to herbaria all over the world. He visited San Diego in 1882 and made a brief trip into Baja California. For a biographical sketch, see Evans (1935); and for a full biography, see Davis (1936).

PURPUS, CARL A[LBERT] (?1851-1941)

Dr. Purpus was a botanical collector, whose Mexican collections over many years were identified and distributed by his friend T. S. Brandegee. Between 1898 and 1912 he gave his address as First and Redwood Streets, San Diego: this was the Brandegees' address from 1894 until 1906, when they moved to Berkeley. From 1913 until the end of his life, his home was Hacienda Mirador, Zacuapam Huatusco, Veracruz. For biographical notes, see Langman (1949) and Ewan (1950, p. 285).

RICH, WILLIAM

Major Rich made natural history collections on the United States and Mexican Boundary Survey.

ROBISON, WILLIAM C[ONDIT] (1914-)

As an undergraduate student at the University of California at Los Angeles, Mr. Robison accompanied Dr. Carl Epling on several field trips through San Diego County. He is now a geographer with the Quartermaster Research and Engineering Center, Natick, Massachusetts.

ROEZL, BENEDICT [or BENITO] (?1823-1885)

Mr. Roezl was a horticulturist who collected widely in the Americas, introducing many kinds of plants into European cultivation and in great quantity. He had in fact the reputation of being a greedy and ruthless collector. He visited San Diego in 1869. For an autobiographical account with brief introductory notes, see Masters and Moore (1874, 1885); and for notes on his visit to San Diego, see McKelvey (1938, p. 95).

SANFORD, OLIVER N[ASON] (1847-1928)

Mr. Sanford was a civil engineer with a broad interest in natural history, especially entomology and botany. A native of Boston, he lived in San Diego about from 1872 to 1899, when he moved to San Francisco. He was a charter member of the San Diego Society of Natural History.

SCHOENEFELDT, LUDWIG

Mr. Schoenefeldt was a hospital steward in the U. S. Army, who served in the biological section of the United States and Mexican Boundary Survey. According to Mearns (1907, p. 6), he collected plants assiduously from Fort Yuma to the Pacific Ocean and on San Clemente Island, from April 6 to September 9, 1894.

SCHOTT, ARTHUR [CARL VICTOR] (1814-1875)

A native of Germany, Mr. Schott came to the United States in 1850. As assistant on the United States and Mexican Boundary Survey, he studied the geology and made large botanical collections. He was with the party of Lt. Michler, which came to San Diego by sea and on November 16, 1854, departed for Fort Yuma. For a biographical note, see Standley (1920, p. 92).

SCHUMO, Mrs. SILAS L.

According to records of the Academy of Natural Sciences of Philadelphia, Mr. Schumo donated shell collections, from the late 1890's to 1903. Mrs. Schumo gave at least one botanical specimen from California, in 1899. Probably she collected the specimen of *Eriogonum*. No further information is available concerning either Mr. or Mrs. Schumo.

SCOTT, Miss

With the type specimen of *Carex praegracilis*, according to Dr. Reed Rollins, there is a long note, presumably in Miss Scott's hand, comparing this with another species and suggesting that it was new. From this note it appears that Miss Scott must have had some knowledge of botany. No further information about her is available.

SPENCER, MARY [EVELYN] F[ISK] (1841-1940)

Mrs. Spencer was an amateur botanist who collected extensively in Europe and, in her later years, in the desert areas of San Diego County. Her herbarium is at Oberlin College. For a report on her life and work, see Grover (1941).

STARK, B[YRON] D[AVID] (1894-)

Mr. Stark was a nurseryman for the Rancho Santa Ana Botanic Garden. He is now retired and lives in Whittier.

STOKES, SUSAN G[ABRIELLA] (1868-1954)

Miss Stokes moved with her family to San Diego in 1886; and she taught high school here from 1914 to 1936. From college days to the end of her life, her main interest was the genus *Eriogonum*. For a sketch of her life and an appreciation of her work, see Howell (1955).

THURBER, GEORGE (1821-1890)

From his early employment in pharmacy, Dr. Thurber became interested in drug plants and thus took up the study of botany. As botanist, quartermaster, and commissary, with the United States and Mexican Boundary Survey, he came overland from Texas to San Diego, reaching what is now eastern San Diego County in February 1852; and he began the return trip in May 1852. For his own notes on this trip, see Gray (1855); and for a biographical sketch, see Woodward (1936).

VALENTIEN, ANNA M[ARIE BOOKPRINTER] (1862-1947)

Mrs. Valentien was a noted painter and sculptress, who taught arts and crafts in San Diego for many years. Her husband, Albert Robert Valentien (1862-1925), after retiring as head decorator for Rookwood Pottery, Cincinnati, began painting the wildflowers of California. The Valentien paintings in the San Diego Museum of Natural History include some 1200 subjects in watercolor. Mrs. Valentien collected specimens for her husband to paint; and these were later sent to Dr. H. M. Hall for identification.

VASEY, GEORGE (1822-1893)

Always interested in botany, Dr. Vasey had his first real opportunity as a botanist when he joined Major John Powell in an expedition to Colorado in 1868 (Darrah 1951). From that time botany was his sole interest. He was botanist in the U. S. Department of Agriculture from 1872 until his death. His special interest was the grasses. For a biographical sketch, see Maxon (1936).

WEED

The original collector of *Calochortus Weedii* was given simply as "Weed". His identity remains a mystery. The suggestion is made that he might possibly be Charles Leander Weed, a photographer for many years resident in San Francisco and known as the first photographer in the Yosemite (Russell 1947). Charles Weed's name is absent from the city directory of San Francisco for several years, including the time preceding the description of the *Calochortus*. But there is no positive evidence that he was in San Diego at this time or that he was the collector.

WIESLANDER, A[LBERT] E[VERETT] (1890-)

Mr. Wieslander is a forester with the California Forest and Range Experiment Station. He collected in San Diego County in the survey of vegetation for the Vegetation Type Map project (Wieslander 1935).

WIGGINS, IRA L[OREN] (1899-)

Dr. Wiggins is professor of biology and director of the Natural History Museum at Stanford University and an authority on the flora of the Sonoran Desert. From 1921 until 1928 he collected widely in San Diego County in preparation for the flora of the County that was his doctoral dissertation (Wiggins 1929).

WOLF, CARL B[RANDT] (1905-)

Dr. Wolf collected extensively throughout California while he was botanist at the Rancho Santa Ana Botanic Garden, from 1930 to 1945.

WOODHOUSE, SAMUEL W[ASHINGTON] (1821-1904)

Dr. Woodhouse was physician and naturalist with Lt. Sitgreaves' expedition down the Zuni and Colorado Rivers in 1851. From Fort Yuma they crossed the Colorado Desert to San Diego in December 1851.

OLD PLACE NAMES

A few place names appearing in the list are no longer used and will need explanation. Daniel Cleveland's notes concerning three of these names were published by Mason (1937). Further details have been furnished by Mr. Bertram B. Moore of San Diego, formerly Assistant County Surveyor.

CORDILLERAS OF CALIFORNIA. In the report of Emory (1848) this expression refers to the mountains along the route from San Felipe to Santa Ysabel by way of Warners Ranch.

LARKIN'S (or LARKEN'S) STATION. According to Cleveland this is an old name for Jacumba. Mr. Moore agrees, adding that it is shown as "Larkins" on the San Diego County map of 1889 by J. D. Schuyler. According to McVaugh (1956, p. 242), "Larkin" appears in township 17-18 south, range 7 east, on the Immigration Association's map of California, ca. 1885. McVaugh added that it was on the site of Buckman's Springs, but that is in township 16 south, range 5 east. Perhaps he meant Bankhead Springs, which is about 4 miles northwest of Jacumba.

MILQUATAY, according to Mr. Moore, was an Indian encampment in the Campo Valley; it is shown on the San Diego County map of 1872 by M. G. Wheeler, County Surveyor.

STONEWALL MINE was about a mile north of Stonewall Peak in the Cuyamaca Mountains.

TALLEY'S (or TALLY'S) RANCH according to Cleveland was in a valley at the base of South Cuyamaca Peak, about 8 miles south of Julian. But according to Palmer's notes, as quoted by McVaugh (1956, p. 326), it was about 5 miles south of Julian, in the Stockton Valley. And according to Mr. Moore it is shown about 4 miles south of Julian, in section 21, township 13 south, range 4 east, on the township plat of 1876 and on the San Diego County map of 1889 by J. D. Schuyler.

TIGHE'S (or TIGH'S) RANCH was about 7 miles east of Ramona, on the old road from San Diego to Julian. On the township plat of 1875, according to Mr. Moore, it is shown in section 16, township 13 south, range 2 east. According to Cleveland it was also given on some botanical labels as "Luckett" after an earlier owner.

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TRANSACTIONS
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SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME XII, No. 23, pp. 407, 408 FEBRUARY 1, 1960

A NEW RACE OF POCKET GOPHER (THOMOMYS) FROM SAN FERNANDO MISSION, BAJA CALIFORNIA, MEXICO

BY

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Curator of Birds and Mammals, San Diego Society of Natural History

The study of a small series of Pocket Gophers (*Thomomys*) from San Fernando Mission, Baja California, Mexico, has revealed characters which were not apparent in the limited number of specimens available to the writer when he named *Thomomys bottae abbotti* (Huey 1928) or when he reviewed the Pocket Gophers of Baja California (Huey 1945). The species is now known as *Thomomys umbrinus* (Hall and Kelson, p. 413, 1959).

The new race may be known as

Thomomys umbrinus brazierhowelli[1] subsp. nov.
SAN FERNANDO POCKET GOPHER

TYPE.—Adult male; from San Fernando Mission, Baja California, Mexico, lat. 30°; collected by A. Brazier Howell and skinned by Laurence M. Huey, February 26, 1958; no. 18725, collection of the San Diego Society of Natural History.

CHARACTERS.—*Thomomys umbrinus brazierhowelli* is a dark, dull tawny colored gopher with a darker and, in some specimens blackish, median dorsal stripe. It has a blackish colored face with black pouch linings. The dull tawny color extends over the sides and underparts, while the feet and tip of the tail are white.

Compared with *Thomomys umbrinus abbotti*, the race that lives along the Rosario River to the northwest, *T. u. brazierhowelli* is much darker, with the blackish dorsal color and black face and cheek pouches outstanding. The skull of *T. u. brazierhowelli* differs from that of *T. u. abbotti* in being more angular and rugose, with wider, square arching and heavier-boned zygomatic arches. The bullae are more rounded and inflated, lacking the anterior flattened surfaces found in *T. u. abbotti*.

[1] Named in honor of A. Brazier Howell, a lifelong friend, charter member and past president of the American Society of Mammalogists.

Compared with *Thomomys umbrinus catavinensis* (Huey 1931) and *Thomomys umbrinus ruricola* (Huey 1949), both of which occur to the south and are brownish gray in color, *T. u. brazierhowelli* contrasts sharply: its buff tawny color sets it apart readily. It is larger than either; and its skull is larger, more angular, and more heavily boned.

MEASUREMENTS OF TYPE.—Total length, 235; tail, 76; hind foot, 33; ear, 5. *Skull*: greatest length, 40.2; spread of maxillary arches, 25.9; length of nasals, 14.3; interorbital constriction, 7.0; alveolar length of upper molar series, 8.2.

RANGE.—Known only from the type locality.

SPECIMENS EXAMINED.—*Thomomys umbrinus abbotti*, 17 from 1 mi. e. of El Rosario, Baja California (type locality). *Thomomys umbrinus catavinensis*, 12 from Cataviña, Baja California (type locality); 2 from Rancho Ramona, 13 mi. sw. of San Agustín, Baja California. *Thomomys umbrinus ruricola*, 1 (the type) from 4 mi. n. of Santa Catarina Landing, Baja California. *Thomomys umbrinus brazierhowelli*, 14 from San Fernando Mission, Baja California (type locality).

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TRANSACTIONS
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TWO NEW RACES OF PEROGNATHUS SPINATUS FROM BAJA CALIFORNIA, MEXICO

BY

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The study of a series of *Perognathus spinatus* from the rocky region about the old Mission of San Fernando, together with specimens collected years ago from localities on the western slope of the Sierra San Pedro Mártir and the southern parts of the peninsula, reveals the presence of two undescribed races, the descriptions of which follow:

Perognathus spinatus oribates[1] subsp. nov.
SAN FERNANDO SPINY POCKET MOUSE

TYPE.—Adult male; from San Fernando Mission, lat. 30° N., Baja California, Mexico; collected by Laurence M. Huey, February 27, 1958; no. 18742, collection of the San Diego Society of Natural History.

CHARACTERS AND COMPARISONS.—*Perognathus spinatus oribates* is recognizable by its very spiny and grizzled blackish dorsal pelage, darker than in other races, and its small body, having a proportionately long, well tufted, bicolored tail. As in all other races of *P. spinatus*, the underparts and feet are white, with little or no blending of color on the sides.

Compared with *Perognathus spinatus rufescens*, the desert race found living on the light-colored granite slopes of the mountains in northeastern Baja California, *P. s. oribates* is much darker in dorsal pelage color, with a skull slightly heavier-boned in most dimensions. Compared with *Perognathus spinatus prietae*, the race that occupies the north central midpeninsular region, *P. s. oribates* is slightly darker and more grizzled, with a proportionately longer tail. The skull of *P. s. oribates*, when compared with the skulls of both these races, is rounder as seen either from the side or from the rear and has heavier maxillary arches and nasals; the bullae also are more rounded and inflated.

[1] From the Greek, *oribates*, mountain ranging.

The newly described race is more closely allied in pelage color to *Perognathus spinatus peninsulae*, found at the extreme southern part of the peninsula; however it is set apart from the southern relative by its smaller cranial and body size.

MEASUREMENTS OF TYPE.—Total length, 192; tail, 112; hind foot, 22; ear, 5. *Skull*: greatest length, 24.9; width across bullae, 12.8; interorbital constriction, 6.5; nasals, 9.1; toothrow, 3.5.

RANGE AND REMARKS.—*Perognathus spinatus oribates* is found living on rocky terrain from the western foothills bordering Llano de San Agustín, at lat. 30° N., northward along the arid foothills of the western slopes of the Sierra San Pedro Mártir to Las Cabras, inland and east of San Telmo, near lat. 31° N.

This is the westernmost race of the *Perognathus spinatus* group, which is an example of a desert species whose range rounds the southern end of the Sierra San Pedro Mártir to terminate on the western slope in the San Quintín area. Two species of pocket mice, *Perognathus baileyi* and *Perognathus arenarius*, a kangaroo rat, *Dipodomys merriami*, and sandpaper plant, *Petalonyx linearis*, are other examples of this distribution.

Perognathus spinatus broccus[2] subsp. nov.
SAN IGNACIO SPINY POCKET MOUSE

TYPE.—Adult male; from San Ignacio, lat. 27° 17′ N., Baja California, Mexico; collected by Laurence M. Huey, March 18, 1928; no. 6891, collection of the San Diego Society of Natural History.

CHARACTERS AND COMPARISONS.—This race, *Perognathus spinatus broccus*, differs from its nearest relative to the north, *P. s. prietae*, in its larger size and proportionately longer tail. The skull is flatter and less rounded. The most pronounced character, for which the race is named, is a well developed pointed projection on the underside of the zygomatic arch where the jugal joins the maxilla.

Compared with the southern race, *Perognathus spinatus peninsulae*, *P. s. broccus* is smaller, with smaller ears and smaller skull. The pointed projection on the zygomatic arch, however, is larger and more prominently developed.

MEASUREMENTS OF TYPE.—Total length, 204; tail, 118; hind foot, 22; ear, 5. *Skull*: greatest length, 25.6; width across bullae, 13.1; interorbital constriction, 6.6; nasals, 9.8; toothrow, 3.4.

RANGE.—*Perognathus spinatus broccus* occurs, so far as known, only over the lava-covered slopes of the Sierra de la Giganta.

REMARKS.—The accompanying table gives the average measurements of the male specimens used in the preparation of this paper. A like tabulation was made of female specimens, but it gave only an indication of relatively smaller sizes for that sex.

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[2] From the Latin, *broccus*, projecting.

TABLE 1. Average measurements of male specimens of *Perognathus spinatus*

	Total length	Tail	Hind foot	Ear	Greatest length of skull	Width across bullae	Inter-orbital constriction	Nasals	Tooth-row
P. s. spinatus[1]	184.8	106.4	22.2	5.0	24.4	12.2	6.2	9.2	3.5
P. s. rufescens[2]	173.2	99.0	21.3	5.6	24.0	11.9	6.3	9.0	3.3
P. s. oribates subsp. nov.[3]	190.4	110.4	22.0	5.0	24.6	12.7	6.3	9.3	3.4
P. s. prietae[4]	184.4	105.4	21.0	5.2	24.5	12.5	6.1	8.8	3.3
P. s. broccus subsp. nov.[5]	196.0	112.2	21.4	5.2	25.6	12.7	6.4	9.8	3.3
P. s. peninsulae[6]	199.9	111.2	23.8	5.6	26.4	13.3	6.8	10.0	3.4

[1] 5 specimens from 3 miles north of Bard, Imperial County, California
[2] 8 specimens from San Felipe Canyon, La Puerta, and vicinity, San Diego County, California
[3] 5 specimens from San Fernando Mission, Baja California, Mexico (Type locality)
[4] 5 specimens from 25 miles north of Punta Prieta and from San Borjas, Baja California, Mexico (including type)
[5] 5 specimens from San Ignacio, Baja California, Mexico (Type locality)
[6] 5 specimens from San José del Cabo, Baja California, Mexico (Type locality)

SPECIMENS EXAMINED

Perognathus spinatus spinatus: 25. (California: Morongo Valley, San Bernardino County, 2; Frink, Imperial County, 6; 3 mi. n. of Bard, Imperial County, 7; 1 mi. n. of Potholes, Imperial County, 9; Baja California: San Felipe, 1.)

Perognathus spinatus rufescens: 13. (California: Palm Springs, Riverside County, 1; mouth of Palm Canyon, Borrego Valley, San Diego County, 2; San Felipe Canyon, San Diego County, 3; La Puerta Valley, San Diego County, 7.)

Perognathus spinatus oribates: 17. (Baja California: Rancho Ramona, 8 mi. n. of Santa Catarina, 4; San Fernando Mission, 12; Las Cabras, 1.)

Perognathus spinatus prietae: 33. (Baja California: Cataviña, 1 (not typical); 25 mi. n. of Punta Prieta, 12; San Borjas Mission, 7; 12 mi. e. of El Arco, 3; Santa Gertrudis Mission, 6; Barril, 4.)

Perognathus spinatus broccus: 26. (Baja California Sur: San Ignacio, 11; Llano de San Bruno, 1; 12 mi. s. of Mulegé, Concepción Bay, 2; Canipolé, 1; Comondú, 11.)

Perognathus spinatus peninsulae: 30. (Baja California Sur: La Paz Mesa, 19 mi. n. of La Paz, 2; 7 mi. nw. of San Bartolo, 11; Miraflores, 3; 7 mi. s. of Miraflores, 1; Los Barriles, 1; San José del Cabo, 8; 9 mi. ne. of Cape San Lucas, 2; Cape San Lucas, 2.)

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COMMENTS ON THE POCKET MOUSE, PEROGNATHUS FALLAX, WITH DESCRIPTIONS OF TWO NEW RACES FROM BAJA CALIFORNIA, MEXICO

BY

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BY

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Curator of Birds and Mammals, San Diego Society of Natural History

During the past thirty years there have accumulated in the collection of the San Diego Society of Natural History representative specimens of the Pocket Mouse, *Perognathus fallax*, from a number of localities ranging from southern California to central Baja California, Mexico.

The present known range of *Perognathus fallax* is from latitude 34° 30′ N to latitude 27° 30′ N., mainly west of the desert, but it includes both slopes of the backbone mountains of southern California. However, so far as is now known no specimens have been collected or records made from the eastern slopes of the Sierra Juárez or the Sierra San Pedro Mártir in northern Baja California nor from above the 5000 foot level along the western slopes of the mountains. At the southern extent of the present known range, the species is found in isolated localities along the Pacific coast and at a few localities inland where vegetative conditions which furnish food, exist.

As with other mammalian species that occupy both coastal and desert or near-desert areas, there is shown in the assemblage of specimens of *Perognathus fallax* the dark to light or pallid colored pelages. There are also variations shown in specimens taken from localities along the coastal section of the range from north to south. This coastal section, too, runs the gamut from a cool humid to a hot arid climate, though the effect on the species does not parallel that of the west-to-east climatic variation. This geographical and climatological influence has developed not only divergent pelage color but size differences as well. Hence in areas such as the coastal Viscaino Desert region of Baja California, with its xerothermic plant life, the species has been dwarfed, while inland, the populations show some characters, particularly those of pelage color and size, of the more northern populations.

It has been of great interest to find within the ranges of other mammalian species, whose populations are to be found living down the length of this long peninsula, or in fact from the cooler humid northern coastal section southward into the arid central parts, characters that parallel those shown by the *Perognathus fallax* group, the subject of the present study. Dwarfing, light and dark pelage, or brightening of color patterns are amongst the more prominent.

Notable changes are likewise to be found in the vegetation both on land and in the sea. One of the most important factors to consider in the study of this species of *Perognathus* is the effect of climatic conditions within its range. For instance, rainfall and the resulting plant growth which furnishes food upon which these rodents live, in this coastal area differ considerably from north to south. At San Diego, California, which is not the northernmost section of the species' range but which may be taken as a central part of the nominate race, *P. fallax,* the average mean rainfall is 9.2 inches annually. Seventy miles southward at Ensenada, Baja California, the average rainfall decreases slightly, though the flora is similar to that of San Diego, and *P. fallax* is still to be found in typical character.

A range of mountains of about 3000 feet elevation lying in an east-west direction south of Ensenada, reaches the sea. The more arid south face of these hills marks a sharply changing flora. Below this barrier the annual rainfall average is much less, only 5.2 inches at San Quintín. However, fog is more prevalent. In this region, where less rain falls, the vegetation is more scrubby and of a very different type, with cacti and a dense, very thorny species of wild rose predominating. Here a darker, robust race of *P. fallax* is found.

For the southernmost coastal section of the known range of the *P. fallax* group, near Punta Eugenio, Baja California, where the race *P. f. inopinus* is found, rainfall data are not available; but the flora of the region proves to be a good index of the annual precipitation: it is very sparse, dwarfed, and thorny. This is a land of seasonal fogs, with erratic and irregular rainstorms, which, when occurring, are often short and violent. The influence of the fog is mainly coastal and epiphytic lichens are found on most of the shrubs. This lack of regular rainfall reduces annual plants and grasses to a low measure, and the seed- and grass-eating mammalian fauna is therefore sparse.

The moisture-laden air is gradually dissipated inland with the rise in elevation of the terrain until the backbone of the peninsula is reached, which so far as is now known is the range limit of the species *P. fallax.* Along the greater part of the length of the peninsula of Baja California, eastward from the mountainous backbone the terrain falls rapidly to the shores of the Gulf of California and offers no habitat suitable to *P. fallax.*

In the spring of 1949 the writer visited the Gulf coast at latitude 29° 30′ N. At that time the only rain for over six years had fallen in the previous two months. Dried and bleached shrubs were everywhere, and the few cattle owned by a local ranchero had starved to death. It is difficult to express in words the sharp changes that take place in such short distances in this arid land. Yet the profound influence upon both plant and mammalian life is quite apparent to the naturalist.

The types of the three named races were all taken on the perimeter of the known range of the species.

Perognathus fallax fallax Merriam

SAN DIEGO SHORT-EARED POCKET MOUSE

Perognathus fallax Merriam, N. Am. Fauna. 1: 19, 20. October 25, 1889.

TYPE.—Adult male; from Reeche Canyon, 3 miles southeast of Colton, San Bernardino County, California; collected by Frank Stephens, April 21, 1887; no. $\frac{15889}{22684}$, collection of the U.S. National Museum.

RANGE.—Southwestern California and northwestern Baja California, from the vicinity of Riverside and San Bernardino, almost exclusively on the Pacific drainage to Ensenada, Baja California, inland to San Matias Pass, where examples show characters strongly influenced by the desert regions, thence north along the lower slopes of the Sierra Juárez to Jacumba, just north of the International Boundary. The population of this latter locality is not typical and, oddly enough, lives within 3 airline miles of the type locality of *P. f. pallidus*, however in a very different plant association and at an elevation 1200 feet higher.

REMARKS.—It is unfortunate that the type of the nominate race should have been selected from a population living in the semi-arid San Bernardino Valley. A more western coastal locality would have offered a far better example of this race.

SPECIMENS EXAMINED.—CALIFORNIA: *San Bernardino County*—Lytle Creek, 1; San Bernardino, 1; Herron's Ranch, Reeche Canyon, 4 (topotypes). *Riverside County*—Riverside, 1; Box Spring, 1; Perris, 5; Winchester, 1; San Jacinto Lake (now drained, specimen collected by A. W. Anthony, June 28, 1895), 1; Aguanga, 2. *San Diego County*—Ballena, 1; Dulzura, 12; Dehesa, 2; Lake Hodges, 8; El Monte, 3; Mission Gorge, 8; Vista, 1; 2 mi. s. of Del Mar, 6; 3 mi. s. of Del Mar, 3; 2 mi. se. of Bonita, 5; Ocean Beach, 1; San Diego, 3; mouth of Tia Juana River, 2. BAJA CALIFORNIA: El Valle de las Palmas, 3; n. side of Descanso Bay, 1; Ensenada, 1; 6 mi. e. of Ensenada, 1; Boundary s. of Jacumba, California, 8; Sangre de Cristo, 19; El Valle de la Trinidad (not typical), 18; summit of San Matias Pass (not typical), 13. Total 143.

Perognathus fallax pallidus Mearns

PALLID SHORT-EARED POCKET MOUSE

Perognathus fallax pallidus Mearns, Proc. Biol. Soc. Wash. 14: 135, 136. August 9, 1901.

TYPE.—Adult female; from Mountain Springs, about 2500 feet elevation, east slope of the Coast Range near the Mexican Boundary, Imperial County (formerly San Diego County), California; collected by Dr. Edgar A. Mearns, May 16, 1894; no. 61007, collection of the U.S. National Museum.

RANGE.—Southern margin of the Mohave Desert along the north slopes of the San Bernardino Mountains and western rim of the Colorado Desert south to the Mexican Boundary.

REMARKS.—*Perognathus fallax pallidus* may be expected southward a short distance below the Boundary; however, extensive collecting produced no specimens at two very likely places on the eastern desert slopes of the Sierra Juárez: Gaskell's Tanks, about 25 miles, and Las Palmitas, about 60 miles, from the type locality.

The apparent end of the range of *P. f. pallidus* has given cause to investigate the ranges of other vertebrates living near this area. Some interesting problems both ornithological and mammalogical were found, though with this casual study, the solution of range limitations was not determined. Much work remains to be accomplished in this region before definite statements can be made.

SPECIMENS EXAMINED.—CALIFORNIA: *Riverside County* — Cabezon, 1. *San Diego County* — San Felipe Narrows, 2; San Felipe Valley, 3; San Felipe Canyon, 2; Mason Valley (= La Puerta Valley), 17; Granite Mountain, 2. *Imperial County* — Mountain Springs, 26 (type locality). Total 53.

Perognathus fallax majusculus subsp. nov.
SAN QUINTÍN SHORT-EARED POCKET MOUSE

TYPE.—Adult male; from San Quintín, Baja California, Mexico; collected by Laurence M. Huey, June 29, 1947; no. 15952, collection of the San Diego Society of Natural History.

CHARACTERS.—This race is darker in dorsal coloration than any other member of the species, outstandingly so when a series of specimens is viewed. It has a very robust body with a relatively shorter tail that is brightly bicolored and well tufted. An unusually large number of spine-like white bristle hairs are present over the posterior part of the body when in fresh pelage.

The chief differences of this race, however, are cranial. The skull of *P. f. majusculus* as compared with skulls of the other races is more heavily boned, with larger more inflated bullae, and is more arched dorsally when viewed in profile. There are also minor differences in dentition.

Compared with specimens from the more southern interior localities, *P. f. majusculus* is darker in dorsal pelage color and larger in body size. It differs in the same respects from the southern coastal race, *P. f. inopinus,* which is the smallest race of the species.

MEASUREMENTS OF TYPE.—Total length, 191; tail, 105; hind foot, 24; ear, 6. *Skull*: greatest length, 26.7; mastoid breadth, 14.7; interorbital constriction, 6.9; nasals, 9.8; tooth row, 3.6.

RANGE.—San Quintín district, from south of Santo Tomás to El Rosario. Most abundant on the coastal mesas up to 1200 feet altitude.

SPECIMENS EXAMINED.—BAJA CALIFORNIA: 3 mi. s. of San Telmo, 4; Las Cabras, 7; Santo Domingo (lat. 30° 47′ N), 17; 1 mi. s. of San Ramón, 6; s. of San Ramón, 2; north end of San Quintín, 3; 10 mi. se. of San Quintín, 14; Santa María, near San Quintín, 1; 5 mi. e. of San Quintín, 2; 1 mi. e. of El Rosario, 2; 4 mi. e. of El Rosario, 1; 10 mi. e. of El Rosario, 2; mouth of Canyon San Juan de Dios, 3; Aguaita, 4 (not typical). Total 93.

Perognathus fallax inopinus Nelson and Goldman
TURTLE BAY SHORT-EARED POCKET MOUSE

Perognathus fallax inopinus Nelson and Goldman, Proc. Biol. Soc. Wash. 42: 110. March 25, 1929.

TYPE.—Adult male; from Turtle Bay (also known as San Bartolomé Bay), Baja California Sur, Mexico; collected by Alfred W. Anthony, August 1, 1896; no. 81059, collection of the U.S. National Museum (Biological Survey Coll.).

RANGE.—Along the immediate coastal shelf from Turtle Bay (27° 41′ N) to Santa Catarina Landing (29° 50′ N).

REMARKS.—The southern race, *Perognathus fallax inopinus,* differs considerably from its northern relatives both in lighter coloration of pelage and in smaller body size. Without question these characters are the results of environmental conditions under which *P. f. inopinus* lives.

SPECIMENS EXAMINED.—BAJA CALIFORNIA: Santa Rosalía Bay (28° 40′ N), 4; Santa Catarina Landing, 2. Total 6.

Perognathus fallax xerotrophicus subsp. nov.
ARID PLAINS SHORT-EARED POCKET MOUSE

TYPE.—Adult male; from 2 mi. northwest of Chapala, Baja California, Mexico; collected by Laurence M. Huey, October 15, 1930; no. 8310, collection of the San Diego Society of Natural History.

CHARACTERS.—Dorsally this race, when viewed in series, is slightly paler than *P. f. majusculus* but is decidedly darker than the coastal form, *P. f. inopinus,* and than *P. f. pallidus,* the race that inhabits the California desert.

In body size, *P. f. xerotrophicus* is similar to the nominate race, *P. f. fallax,* and to the desert form, *P. f. pallidus;* it is smaller than *P. f. majusculus* and larger than *P. f. inopinus.* It differs from them all by having a longer tail.

Several well-marked cranial characters differentiate *P. f. xerotrophicus* from its nearest comparatives. From *P. f. majusculus,* it differs in having a lighter-boned skull, less inflated bullae, and a smaller braincase, with a flatter less curved profile and more slender rostrum. Compared with *P. f. inopinus,* the skull is heavier boned and larger in size.

MEASUREMENTS OF TYPE.—Total length, 210; tail, 127; hind foot, 24; ear, 6. *Skull*: greatest length, 26.8; mastoid breadth, 14.0; interorbital constriction, 6.2; nasals, 10.4; toothrow, 3.7.

RANGE.—Found in an irregular pattern all inland, from San Fernando Mission south to Punta Prieta and San Andreas.

SPECIMENS EXAMINED.—BAJA CALIFORNIA: San Fernando Mission, 26; 5 mi. se. of San Fernando, 1; San Agustín, 21; Rancho Ramona, 7 mi. n. of Santa Catarina, 15; Onyx, 4; 3 mi. s. of El Mármol, 2; 13 mi. nw. of Chapala, 4; 2 mi. nw. of Chapala (type locality), 5; 25 mi. n. of Punta Prieta, 1; San Andreas (not typical), 9. Total 88.

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INHERENT AND APPLIED CAMOUFLAGE IN THE SUBFAMILY GEOMETRINAE (LEPIDOPTERA), INCLUDING THREE NEW LIFE HISTORY STUDIES

BY

JOHN ADAMS COMSTOCK

San Diego Society of Natural History

SAN DIEGO, CALIFORNIA
PRINTED FOR THE SOCIETY
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FIG. 1. Mature larva of *Nemoria delicataria* Dyar on *Eriogonum fasciculatum*, approximately X 5.

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INHERENT AND APPLIED CAMOUFLAGE IN THE SUBFAMILY GEOMETRINAE (LEPIDOPTERA), INCLUDING THREE NEW LIFE HISTORY STUDIES

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Illustrations by the Author

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Entomologists have long been fascinated by the remarkable adaptations of certain insects in protective coloration and form. Among the North American moths of the subfamily *Geometrinae (Hemitheinae)*, this type of protection is developed to an unusual degree. The mature insects of this group are predominantly green of various shades, and their wings are more or less leaflike so that they blend with their verdant habitat. In addition, the larvae usually resemble, in form and color, the particular portion of the specific plant on which they feed. This frequently is true for nearly the entire cycle of larval growth, during which they molt several times and not infrequently improve their camouflage with each change of skin. Furthermore, the posture of the larva enhances its imitative protection. In many species the larva attaches to a branch in such a stance as to simulate exactly a small twig. Some larvae, when in motion, have a nervous twitching of the body and a jerky progressive gait, which resembles the quivering motion of small elements of the plant under the influence of a gentle breeze.

Each species has its individual inherent mechanism of survival. There is a small part of the group, however, in which the individual seems to exercise a choice in its camouflage. The larva bites off small fragments of its food plant and attaches them to short spines on its back with silk as the cementing substance. Thus it is at all times completely covered with parts of the plant on which it feeds. Each time the larva molts, this covering has to be shed and immediately replaced with new fragments. When the larva finally spins a cocoon, it transfers the camouflage to the outside of the covering layer of silk.

I have referred to this type of activity as "applied camouflage", but it must be understood that no reasoning faculty is involved, even though it simulates a rational cause-and-effect reaction. How this habit originated is difficult to explain, but it persists because of its highly protective survival value.

Many authors have published information on the life histories of members of this subfamily, although there are still many concerning which nothing is

known. Three new life histories are recorded here. In addition, I include a list of the known host plants and a bibliography of the published papers covering nineteen species.

Additional Notes on the Life History of Nemoria delicataria Dyar

Since the publication in 1945 of my paper on certain portions of the life history of *Nemoria delicataria*, additional material has come to hand allowing amplification of this record. A mature larva was collected on *Eriogonum fasciculatum* var. *foliolosum* (Nuttall) Stokes, in Del Mar, California, late in August 1958. Notes and drawings were made from this and from the resultant pupa. On August 14, 1959, while I was collecting at black light, a gravid female came in, and obligingly laid a quantity of eggs, which made possible the supplemental information and illustration included here. The eggs were laid on August 15, and hatched on August 21, 1959. The young larvae were immediately placed on tender leaves and also flowers of Toyon (*Photinia arbutifolia* Lindley), which they avidly accepted.

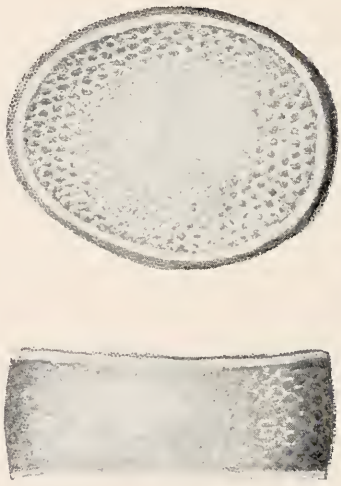

Fig. 2. Egg of *Nemoria delicataria* Dyar, in two views, approximately X 60.

Egg (fig. 2). — The egg is a flat oval, 0.75 mm. long, 0.55 mm. wide, and 0.33 mm. high. When first laid, it is a deep pinkish orange, with a narrow white line circling the edge of the side wall where it joins the top, and with a similar circlet around the base. The surface appears granular but on higher magnification is seen to be covered with a fine grill or network surrounding hexagonal cells. This network is more clearly defined on the superior surface of the egg than it is on the side walls.

LARVA, FIRST INSTAR. — The length is 1.5 mm. and the head width approximately 0.25 mm. The head is bright orange and the ocelli black. The body ground color is bright yellow. A very narrow longitudinal middorsal discontinuous black stripe is present, on each side of which is a wide yellow band. Lateral thereto is a series of dark spots, one to a segment, on each side. Latero-inferior thereto is a broad yellow area. Another series of large raised black spots runs stigmatally. There are numerous small warty tubercles ranged along the body, a pair of which in the cervical area and another pair in the caudal area are larger than the others. A large pyramidal process occurs middorsally on the cauda.

The young larva moves in a series of nervous jerks.

From this point on, no separate record was kept of the larval instars, until the mature stage, but it was noticeable that most or all of the characters of maturity were present.

Another noteworthy fact is that the larvae raised on Toyon were uniformly much darker and more heavily spotted with brown than was the single example reared on *Eriogonum*. The latter, having much more pink and yellow was better adapted to matching the colors of the stems and flowers of its food plant. Conversely, the darker mottled brown form reared on Toyon was well camouflaged when resting on the twigs or stems of its host plant. Since the dark Toyon-feeding mature larva was described in my earlier (1945) paper I will include here the description of the pinker color phase.

MATURE LARVA (fig. 1). — The length is 18 mm. and the head width approximately 1.4 mm. The head is mottled and speckled with various shades of brown. The body color is cream-yellow, which is heavily overlaid with spots and blotches of pinkish brown. Middorsally there is a longitudinal line of broken brown dashes. The body surface has a frosted appearance, owing to a covering of very minute raised granules. In the middorsal area each typical segment bears a single spur, bifurcated at the tip, at the juncture of the forward third of the segment. Caudal to this on each segment there is a pair of short spurs. Dorsolaterally, from the 4th to the 7th segments, a prominent spur projects diagonally forward and laterally, one on the side of each segment. Each is heavily shaded with pinkish brown. The caudal segment has a pair of long spurs which incline caudally. Numerous small nodules occur on various portions of the body.

PUPA. — The illustration of the pupa in my paper of 1945 was a photograph in which some of the structural details were blurred. The description also lacked certain important details. I have therefore prepared a drawing showing the pupa in three aspects (fig. 3) and add the following description:

The length is 11.5 mm. and the greatest width through the area of the patagia, 3 mm. The pupa is fusiform, the cephalic end well rounded and the cauda tapering to a small rounded knob, which is topped by a cremasteric rosette of short recurved red-brown hooklets. The ground color is yellow-tan, but this is heavily obscured by a speckled mottling of red-brown. The maxillae terminate about 0.5 mm. beyond the wing margins, and the antennae reach 0.2 mm. beyond that. The eyes are not prominent. The wings are streaked with

light lines on the nervules, interspersed with minute blackish-brown raised dots. The entire surface of the pupa is finely granular.

An imago emerged October 2, 1958, from a pupa that formed September 8, 1958.

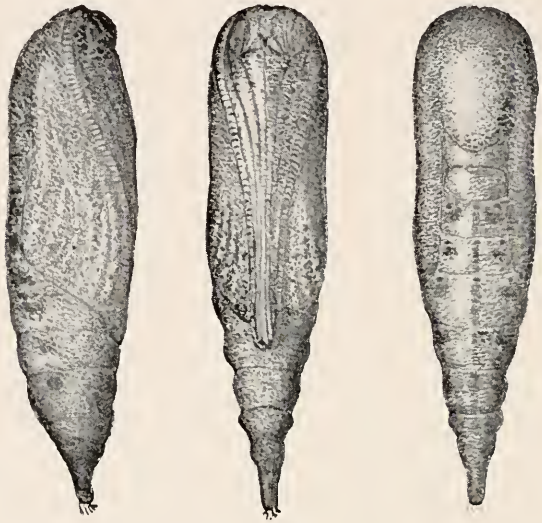

Fig. 3. Pupa of *Nemoria delicataria* Dyar, in three views, approximately X 6.

The Life History of Dichorda illustraria Hulst

A gravid female of this beautiful green geometrid moth came to black light on the evening of August 15, 1959, in Del Mar, California. On the following day numerous eggs were deposited in the rearing jar. These hatched on August 21, 1959, and were immediately transferred to succulent leaves of the known food plant, *Rhus laurina* Nuttall.

Egg (fig. 4). — The egg is a flattened oval 0.8 mm. long, 0.6 mm. wide, 0.2 mm. thick at the more acutely rounded end, and 0.3 mm. thick at the opposite end. The color is a light salmon, except for a narrow white stripe encircling the upper margin and a similar stripe around the basal margin. These white marginal stripes are finely studded, but this bead-like arrangement is discernible only with higher magnification. The side walls are slightly convex and are granular in texture. The top surface is faintly pitted.

Larva, first instar. — The length when extended is 1.75 mm. and the head width approximately 0.5 mm. The head is orange-yellow. There are two pairs of horny protrusions over the crown, and a few short colorless setae are

FIG. 4. Egg of *Dichorda illustraria* Hulst, in two views, approximately X 60.

present on the face. The body is predominantly mottled brownish black. A series of yellow papillae runs longitudinally along the dorso-lateral margin. These are placed on raised yellow bases. The legs are black, except for the hyaline terminal segments. The single pair of prolegs is black. The anal prolegs have a line of raised yellow warty processes on their lateral surfaces. The venter is black.

On September 3, 1959, larvae approximately 5 mm. long, probably in their second instar, were noted as follows: The head width is approximately 0.75 mm. The color is mottled dark brown, tending to blackish brown on the front. The texture is granular. The ocelli and all other parts of the head are nearly unicolorous and are difficult to distinguish. The head is narrower than the first cervical segment. A pair of pointed papillae rising from the first segment extend forward over the crown of the head. The first three body segments expand progressively dorso-laterally. From the 4th to the 8th segments this lateral expansion becomes a series of quadrate flanges suggesting gables, extending outwardly over the stigmatal area. The 9th to 11th segments lack these "gables". The 11th segment bears a pair of processes somewhat similar to those arching over the crown of the head. The body ground color is a soft tan, shaded with areas of brown and mauve. There is a very narrow middorsal black stripe. The ventral surface is mottled dark brown. The legs are dark brown and the prolegs a lighter brown, tinged with pink.

The larva rests in an arched posture. When disturbed, it starts a quivering motion.

On September 10, 1959, the larvae were approximately 12 mm. in length when fully extended. This probably represented their third instar. The head

width is 1 mm. The color of the face is red-brown. The horns arching over the crown from the first segment are much reduced in size. The body color and shape are much as in the previous instar. The most noticeable change is in the darkening of all the edges and ventral surfaces of all the flanges or "gables". The two horns on the 11th segment are relatively longer, stouter, and more blunted at the tips.

From this point on there is little change in the larva. The principal difference is in the progressive shortening of the "horns" on the first segment and a progressive darkening of certain segments and areas. The three cervical segments particularly take on a dark mottling that is in contrast to the remaining segments. A drawing was made of the larva in penultimate instar which is shown in fig. 5.

Finally, on September 21, 1959, the following notes were made of the mature larva. The length, extended, is 21 mm. and the head width, 1.6 mm. The head is unchanged, so far as color and general appearance are concerned. The horns on the first cervical segment are reduced to round knobs at the anterior corners of the segment. The anterior five segments are slightly more darkened and mottled than previously. The middorsal black stripe is more prominent and clearly defined. On the ventral surface, the midventral longitudinal band is wide, and complete from the 1st to the 9th segments. It is dark brown and is margined by a narrow creamy brown line. The dark brown mottling on the first five segments of the ventral surface is in strong contrast to the remaining segments. The crochets on the pair of prolegs are separated into two bundles on each foot, the anterior group smaller than the posterior group. The crochets are brown on a light brown base.

The larva began spinning a fragile cocoon on September 21, 1959, and two days later formed a chrysalis. Pupation occurs on a small branch or twig of the food plant. Freshly cut pieces of leaves are used to cover the outside of the pupal chamber. The internal network is fragile and irregular, and the pupa is clearly discernible within it.

PUPA (fig. 6). — The length is 13 mm. and the greatest width across the shoulders, 4 mm. The pupa is subfusiform, the cephalic end cupped inwardly as a shallow V. The entire surface is rough and heavily streaked and spotted, making it difficult to distinguish the segmental junctures. The ground color is light brown or tan, but this is so heavily obscured with black and dark brown spots as to appear nearly black, except for portions of the abdominal surface. The antennae extend to the wing margins, as do also the maxillae. The metathoracic leg extends out under the tip of the maxilla for a distance of about two-thirds of a segment. The eyes are relatively small and flat and are discernible only on lateral view. The wing cases are darker than the thorax and abdomen, and the nervules are raised and topped by lines of black nodules. There is a middorsal longitudinal dark line on the abdomen, discontinuous at each segmental juncture, and expanding at the caudal margin of each segment. In the center of this dark line there is on each segment a white "tear-drop". Lateral to this middorsal dark line is a longitudinal series of minute black papillae, paired on each segment and

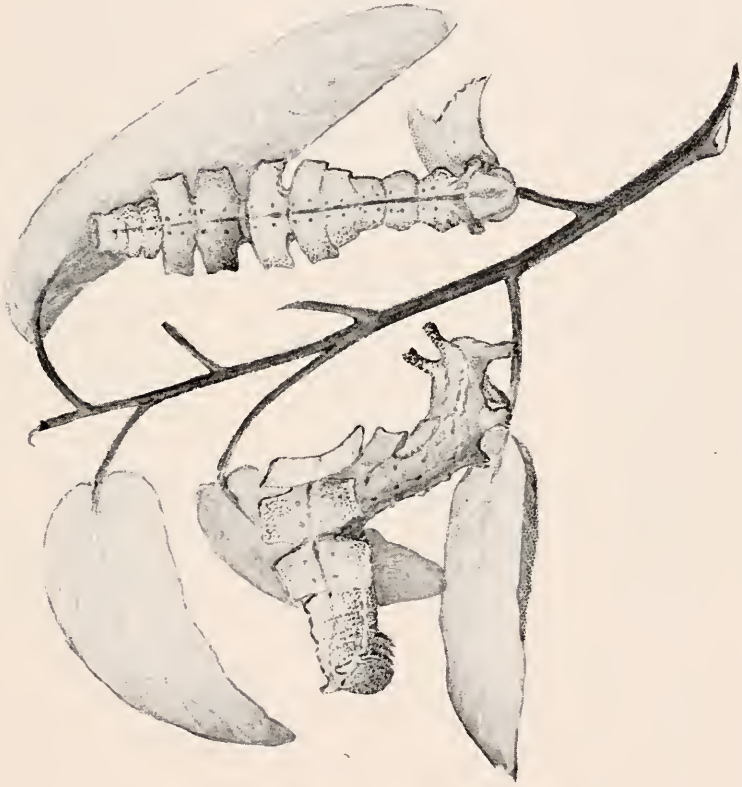

FIG. 5. Larva of *Dichorda illustraria* Hulst in penultimate instar, on *Rhus laurina*, approximately X 3.

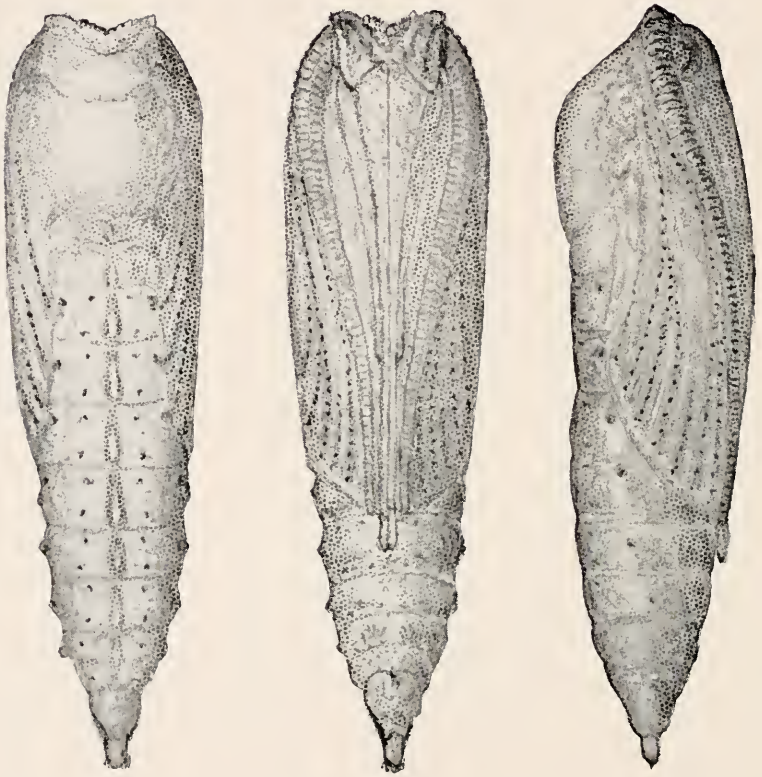

Fig. 6. Pupa of *Dichorda illustraria* Hulst, in three views, approximately X 8.

each one topped by a microscopic seta. The spiracles are raised and relatively prominent. The cremaster ends in a small subquadrate element, the rounded end of which is topped by eight minute recurved hooklets.

The first imago emerged October 11, 1959. Preserved examples of the larva and pupa will be deposited in the Research Department of Yale University.

THE EARLY STAGES OF MEROCHLORA FASIOLARIA GUENEE

Eggs of this species were obtained from a gravid female taken at black light in Del Mar, California, August 14, 1959. They were laid on August 15, and hatched August 25, 1959. The newly emerged larvae were immediately placed on *Artemisia californica* Lessing, their recorded food plant.

FIG. 7. Egg of *Merochlora fasiolaria* Guenèe, in two views, approximately X 60.

EGG (fig. 7). — The egg is a flattened oval, with the sides convex and the top slightly recessed. It is 0.75 mm. long, 0.50 mm. wide, and 0.22 mm. thick. The color is a delicate yellow-green. The white flange circling around the junction of the top and side is well defined, as is also the equivalent white circlet around the base. The surface of the egg is granular, with apparently no grillwork or reticulation such as occurs in the eggs of closely related species.

LARVA, FIRST INSTAR. — The length is 1.8 mm. and the head width approximately 0.25 mm. The head is deep yellow and is crossed by two cream-colored bars, each placed centrally and running vertically across the cheek. These bars continue as stripes onto the cervical segments. There are several minute black dots scattered over the head. The body ground color is yellow but is heavily obscured by a brownish mottling on the 4th to 9th segments. There are two longitudinal rows of spiculiferous processes or nodules, each row placed dorso-laterally. Each nodule has somewhat the appearance of a minute compact bush, and this effect is heightened by the larval habit of covering the top of each nodule with granules scraped from the surface of stems of the food plant. The legs and prolegs are yellow.

The larva is sluggish in habit; when moving it advances with a quivering, jerky, and uncertain gait.

There was great disparity in the rate of growth of the larvae. On October 9, 1959, only eight examples had survived. Six of these were apparently in their second instar, and two were nearly mature.

SECOND INSTAR. — The length is 3 mm. and the head width approximately 0.35 mm. The ground color of the face is light brown, on which the two vertical yellow bands previously noted are present. The body color and form are much as in the prior instar, but there is more tendency of the larva to cover the protruding dorso-lateral knobs with plant fragments. A narrow middorsal longitudinal brown stripe is evident, running the entire length of the body, and a wider stigmatal or substigmatal band is present. The legs are brown and the prolegs mottled yellow-brown. The venter is yellow.

On October 12, 1959, one of the smaller larvae, apparently in its third instar or possibly its fourth, was recorded as follows: The length is approximately 8 mm. and the head width 1 mm. The face is mottled brown and tan. The first cervical segment is characterized by a transverse row of yellow nodules. The body is considerably obscured by pieces of stems and parts of blossoms which the larva has attached to the series of nodules along its back. These nodules have expanded into triangulate processes with spiculate tops. The middorsal brown stripe is more prominent and is edged laterally by yellow lines. Spiracularly, the brownish-yellow band is bordered above by a narrow white stripe and below by white dashes running diagonally on each segment. Inferior thereto is a narrow longitudinal dark brown band which borders on the yellow venter. In the center of the wide yellow ventral band is a narrow brown stripe. The legs and prolegs are mottled brown. The entire surface of the larva is covered with minute round white dots, which give it a frosted appearance.

The larva rests in an arched posture, with the head curled under the abdomen. When it moves, which it does infrequently, it still exhibits the quivering nervous habit recorded for prior instars.

The self-acquired camouflage, together with the mimetic form and coloration of the larva, makes it almost impossible to see specimens at rest on the food plant. It is suspected that the high rate of mortality was due to the accidental discarding of the nearly invisible larvae on dried plants when the food plant was changed.

On October 16, 1959, the two largest individuals were apparently mature. An illustration was made of the largest (fig. 8) and the following notes were recorded: The length of the larva is 16 mm. and the head width, 1.25 mm. The head is speckled with dark brown and tan dots, the dark elements forming a wide band running vertically down the center of the face, bordered laterally with a tan band, and this giving place to a dark patch that covers the side of the head. On the body, the middorsal brown band is less conspicuous than it was in the prior instar, and the yellow band bordering it is wider. The second and third segments are progressively expanded laterally as flattened lobes. These are in line with the large triangular plates that occur laterally on the succeeding segments, but these plates extend upward and outward, and each is topped by a spur. On each of these spurs the larva attaches one or more fragments of the

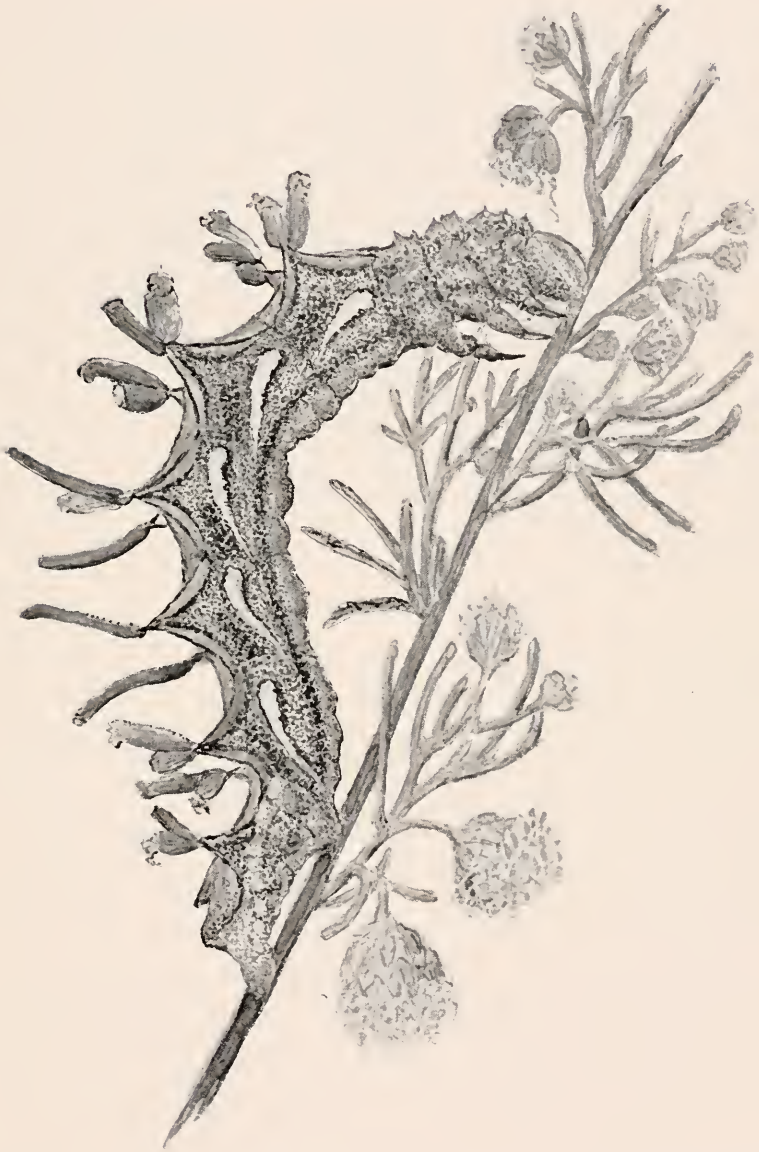

FIG. 8. Mature larva of *Merochlora fasiolaria* Guenèe on *Artemisia californica*, approximately X 7½.

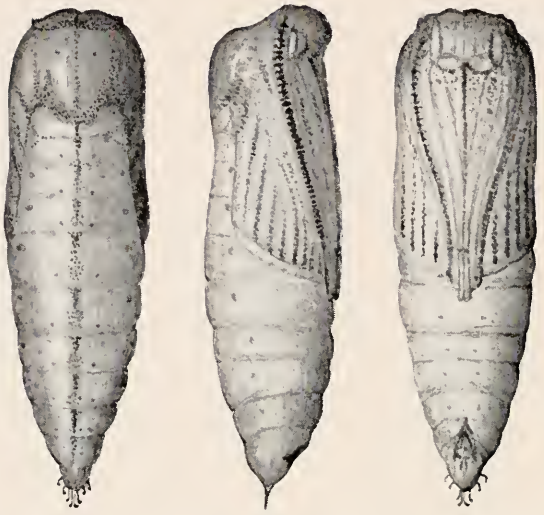

FIG. 9. Pupa of *Merochlora fasiolaria* Guenèe, in three views, approximately X 8.

food plant which it has bitten off. The triangular plates are margined with light yellow bands which are bordered by a fine brown stripe. Inferior to this is a triangulate area of speckled tan, which is crossed by a white diagonal bar that is pointed at one end. There are five of these triangular plates on each side and, in addition, a single middorsal one immediately superior to the suranal triangle.

The larva apparently shows some instinctive ability of selection in choosing the elements with which it camouflages itself. If it places a bit of blossom on one spur, it usually selects the same type of blossom for the opposing spur of the same segment. The caudal and thoracic spurs usually seem to carry blossom fragments, and those between are adorned predominantly with cut ends of elongate leaves. In other particulars the larva of this instar resembles the prior phase.

On October 22, 1959, the largest larva began spinning a loosely woven cocoon on a stem of its food plant. A part of this procedure was to remove its camouflage and attach it to the outer surface of its silk covering. Thus it attained protection for the pupa equal to that maintained in its prior changes.

The second larva began spinning on October 26. At this time the first pupa was removed from its cocoon, illustrated, and recorded.

PUPA (fig. 9). — The length is 8 mm. and the greatest width through the center, 2.5 mm. The pupa is subfusiform, the cephalic end unevenly rounded. The maxillae extend beyond the wing cases, but a portion is obscured by overlapping of the prothoracic legs. The antennae also extend beyond the wing

margins but not so far as do the maxillae. The cremaster is topped by four spurs, with recurved tips that curl laterally. There are also two pairs of shorter hooklets anterior to the caudal group, the tips of which curl medially. On the ventral surface of the cauda there is a dark triangular plate shaped like an arrow point. This bears a few short straight spicules. The spiracles are dark brown, and slightly protruding. The ground color of the thorax, head, and wings is brownish tan, with numerous clusters and lines of dark brown spots. The nervules of the wing cases are accented by these spots, and the central shafts of the antennae are heavily covered and cross-hatched with them. On the dorsal surface there is a middorsal longitudinal line of the same character of spots. The ground color of the abdominal segments is a light tan, slightly tinged with pink.

HOST PLANTS OF GEOMETRINAE

McDonnough in 1938 listed 17 genera, including 80 species, for the *Geometrinae*. Ten new species have been described since (9 recorded by the late John L. Sperry), bringing the total to 90 species, besides several subspecies. Apparently there is no published information on the early stages of 65 of these species. For the remaining 25, a few have been adequately recorded, but others require additional study and illustration. There follows a list of the species for which the host plants are known.

CHETEOSCELIS BISTRIARIA Packard
Solidago sp.

CHLORISSA PISTACIARIA Guenèe
Quercus sp.

CHLORISSA SUBCROCEATA Walker
Quercus sp.

CHLOROCHLAMYS CHLOROLEUCARIA Guenèe
Buds and flowers of *Achillea millefolium* Linnaeus, *Apocynum androsaemifolium* Linnaeus, *Aster* sp., *Eriogonum fasciculatum* Bentham, *Eupatorium perfoliatum* Linnaeus, *Helenium autumnale* Linnaeus, *Helianthus* sp., *Leucanthemum* sp., *Rubus* sp., *Rudbeckia hirta* Linnaeus, and *Zinnia* sp. (cultivated).

CHLOROCHLAMYS ZELLERARIA Packard
Buds and flowers of *Chrysanthemum* sp.; *Eriogonum fasciculatum* Bentham.

DICHORDA ILLUSTRARIA Hulst
Rhus laurina Nuttall.

DICHORDA IRIDARIA Guenèe
Rhus sp.

EUEANA NIVEOCILIARIA Herrick-Schaffer
Condalia sp.

Merochlora faseolaria Guenèe
Artemisia californica Lessing.

Mesothea viridipennata Hulst
Populus sp.; *Prunus* sp.; *Ribes* sp.

Nemoria bistriaria Hubner
Quercus sp.

Nemoria brunnearia Packard
Juglans nigra Linnaeus; *Prunus* sp.

Nemoria darwiniata Dyar
Salix sp.

Nemoria delicataria Dyar
Eriogonum fasciculatum Bentham; *Photinia arbutifolia* Lindley.

Nemoria mimosaria Guenèe
Abies sp.; *Quercus* sp.; *Rubus idaeus* v. *aculeatissimus* Meyrick; *Tsuga* sp.

Nemoria pulcherrima Barnes & McDunnough
Quercus sp.

Nemoria punctularia Barnes & McDunnough
Ceanothus spinosus Nuttall; *Quercus* sp.

Nemoria rubrifrontaria Packard
Ceanothus sp.; *Comptonia* sp., probably *Comptonia peregrina* var. *asplenifolius* (Linnaeus) Fernald; *Eupatorium* sp.

Racheospila herbaria v. hulstiana Dyar*
Flower heads of *Lantana camara* Linnaeus.

Racheospila rubrolinearia Packard*
Myrica sp.; *Quercus* sp.

Racheospila rubromarginaria Packard*
Quercus sp.

Synchlora aerata Fabricius
Ageratum sp.; *Aster* sp.; *Rubus* sp.

Synchlora denticularia Walker
Rudbeckia sp.; flowers of *Solidago* sp. and *Verbena* sp.; *Verbesina* sp.

Synchlora liquoraria Guenèe
Artemisia californica Lessing; buds and flowers of *Chilopsis linearis* DeCandolle; *Coreopsis* sp.; *Eriogonum fasciculatum* Bentham.

Synchlora rubrifrontaria Packard
Eupatorium sp.

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*William T. M. Forbes (1948) placed these three species of *Racheospila* in the genus *Nemoria*.

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DIFFERENTIATION OF THE SOUTHWESTERN TORTOISES (GENUS GOPHERUS), WITH NOTES ON THEIR HABITS

BY

CHAPMAN GRANT

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The true land tortoises of the southern United States and northern Mexico comprize three species of the genus *Gopherus*. The gopher tortoise, *G. polyphemus*, of the southeastern states, is said to range into the Carolinas and westward towards the Mississippi. It digs burrows, lays spherical eggs, is less than half as high as long, and lacks a lateral flare of the posterior part of the carapace. The desert tortoise, *G. agassizi*, occurs in southeastern California, western Arizona, and the southern tips of Nevada and Utah, and in Sonora, Mexico. Like the gopher tortoise, it lays spherical eggs, digs burrows, and is less than half as high as long; but the carapace flares posteriorly, being widest at about the fifth neural scute. It is apparently confined to regions where the creosote bush (*Larrea divaricata*) abounds. Occupying territory between these two species, but not coming in contact with either unless with *G. agassizi* in Mexico, is the smaller Texas tortoise, *G. berlandieri*, found south and southwest of San Antonio and into Nuevo Leon and Tamaulipas, Mexico. It is apparently confined to districts where prickly pear (*Opuntia* sp.) is found. It lays elongated eggs, possibly does not burrow, has a posterior flare like that of *G. agassizi*, is over half as high as long, and has a proportionately larger head; and the nuchal scute is reduced or wanting. There is frequently a yellow stripe across the snout behind the nostrils and a yellow spot behind each orbit. Other distinctions are discussed herein. Little is known of the very young.

Twenty-one specimens of *G. berlandieri* were collected April 10 to 15, 1960, near Hebbronville, Jim Hogg County, Texas. Various sizes and both

sexes were taken in order to experiment on color perception and to determine the size and shape of eggs and the proportions and gross anatomy of adults and thus determine secondary differences between this and the other two species. In this paper *G. berlandieri* is compared to *G. agassizi.*

The temperature at Hebbronville was in the 90's F. by day, and the tortoises were beginning to emerge from hibernation. It is said in Hebbronville that the tortoises hibernate by squirming into the soil, leaving the top of the carapace exposed. A letter from Mr. V. W. Lehman, Wildlife Manager, King Ranch, July 29, 1960, states, "We know that it utilizes burrows for both shelter and hibernation, but there are so many coyote, skunk, armadillo, opossum, and badger dens in the Rio Grande Plain that there is small purpose for the tortoise to make additional excavations." Mr. Lehman's observations may explain why this tortoise has not developed the shovel-like forelegs of *G. agassizi.* I cannot agree that opossums dig.

It is generally agreed that members of this genus cannot swim. A recently published statement that *G. polyphemus* enters the water voluntarily and swims purposefully is unconfirmed. The other two species seem helpless in water.

In Hebbronville there is a rumor that the tortoise destroys quail eggs, but Mr. Lehman writes, "I can state with certainty that the tortoise is not a predator on quail eggs as is often supposed." In the Texas Field Trials for hunting dogs, the score of the dogs is not reduced for "pointing" tortoises, which possibly smell like quail. The local name for the tortoise is "sand terrapin".

EGGS

According to the literature, the eggs of *G. berlandieri* are elongate, but no measurements or ratios appear. Eggs of *G. agassizi* and *G. polyphemus* are nearly spherical. A captive *G. berlandieri* laid three eggs June 8, 1960, buried almost vertically about an inch below the surface and tightly packed. The order of deposition of these is not known. Another egg was found on the surface June 19, another July 9, and another July 13. All eggs were hard and all were nearly circular in cross section except No. 5, which was noticeably flattened, with transverse diameters of 32 and 34 mm. The egg was squeezed and appeared to be hard and firm. Yet this egg when remeasured July 15 was found to have become nearly circular in section. The eggs are white and smooth with a fine granular surface detectable by scratching with the fingernail. The yolk is visible and settles when the egg is tilted. These eggs were sterile, indicating that copulation had not occurred prior to hibernation or as late as early April.

Dimensions in mm.	Width-length ratio (using greatest width)	Date laid
1. 49 x 32.5	.66	June 8, 1960
2. 44 x 31	.70	
3. 43 x 31	.72	
4. 50 x 34	.68	June 19
5. 40 x 32 x 34 (40 x 33 on July 15)	.82	July 9
6. 43 x 34	.79	July 13

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The average axial difference is about 12 mm. The longest egg is about 29 percent as long as the carapace of the female.

Grant (1936) gave the dimensions of three *G. agassizi* eggs:

Dimensions in mm.	Width-length ratio (using greatest width)
1. 42 x 36.5	.87
2. 42 x 37.5 x 35.7	.89
3. 42 x 36	.85

The average axial difference is about 6 mm. or about half that of *G. berlandieri,* which is about 12 mm.

The maximum clearance between pygal and anals is 19 mm. in the specimen of *G. berlandieri* which laid the six eggs. Even without any fleshy parts of the cloacal region being extended into this constriction during deposition, the space through which the eggs must pass is 15 mm. less than the diameter of the widest eggs. Therefore the eggs of this species must be leathery when laid as is the case in *G. agassizi.*

Una Nichols, who has kept *G. agassizi* in captivity in San Diego, California, for thirty years, stated to me that on six occasions she had seen eggs laid and had immediately handled them. The eggs when first laid are flattened to about a third of their final diameter, but they become hard and nearly spherical in a few minutes.

Miller (1932, p. 190) wrote of the desert tortoise: "The egg which was dropped into my hand felt quite warm . . . five degrees [C.] above the [temperature of] the surrounding air . . . At the moment of deposition the egg is decidedly moist so that the shell appears quite translucent although perfectly hard. It is not like some lizard eggs (*Gecko*), soft at deposition and dependent upon exposure to the air for hardening."

GROWTH OF THE SHELL

The smaller the openings between the carapace and plastron, the greater the protection from predators. As the tortoise grows, these openings must enlarge to allow for the growth of legs and head, and it might be expected that they would enlarge proportionately. Actually in the desert tortoise, the head clearance, or anterior opening, increases more than proportionally to the length of the carapace. The posterior, or anal clearance, which is used only for excretion, mating, and egg laying, apparently does not enlarge after maturity, remaining smaller than the width of the eggs.

PROPORTIONS OF ADULTS

The proportions of an adult male of *G. berlandieri* (carapace 176 mm. long) and those of an adult male of *G. agassizi* (carapace 220 mm. long) show differences that are not so pronounced in the young.

	G. berlandieri	*G. agassizi*
Head length[1] to carapace length[2]	.26	.23
Head width[3] to carapace length	.17	.16
Head width to head length	.65	.68
Anterior head width[4] to head length	.28	.38
Forefoot length to forefoot width[5]	.72	.64
Hind foot length to hind foot width[6]	.82	1.00
Foreleg width[7] to head length	.42	.90

[1] From the end of the fleshy snout to the dissected end of the supra-occipital.

[2] Between the rear of the pygal and (in *G. berlandieri*) the most anterior line joining the ends of the first or second pair of marginals, or (in *G. agassizi*) the anterior end of the nuchal.

[3] At the widest point, just posterior to the orbits.

[4] Just anterior to the orbits. The greater constriction in *G. berlandieri* gives it a Chelydra-like appearance.

[5] Length, from the base of the center claw to the center of the crease that denotes the end of the foot. Width, between the outside bases of the outer claws.

[6] Length, from the base of the second claw, excluding adjoining spines, to the heel, excluding spines. Width, between the outer edges of the bases of the outer claws.

[7] From edge to edge at the widest point, excluding the spines on the outer edge.

Color Perception

Walls (1942) discussed color discrimination in turtles in general, not including *Gopherus*, stating that they are red-green perceptive and, curiously, also violet perceptive, although violet is at the opposite end of the spectrum. He also intimated that they may be blue-yellow colorblind. My experiments with captive *Testudo* in Puerto Rico and *Terrapene* in Indiana and Kansas showed that there is a marked reaction to any red object.

Dr. Meyer Wiener, of Coronado, California, wrote in a letter of July 17, 1960, "You are perfectly right in assuming that the eyes of turtles are adjusted to diurnal living. The retina consists almost entirely of cones."

My experiments with *G. berlandieri* cover the combination of color perception, olfaction, and taste, which seem to be used in that order. Red appears to be the most attractive color and a red object is immediately investigated, smelled, tasted, and eaten if suitable. Blue, yellow, and white objects appear not to register except as objects and are not sampled unless accompanied by a pleasing smell. Thus peeled bananas in natural color or dyed blue, yellow, or green, are eaten. Flowers and leaves of red hibiscus (*Hibiscus rosa-sinensis*) are readily eaten, but white hibiscus flowers are ignored unless dyed red, when they are immediately perceived and eaten. If dyed blue or green they are eaten only casually with the green leaves. This may indicate that hibiscus flowers are chosen by color and that the taste is agreeable. I cannot detect any odor from this flower.

FIG. 1. Head and intromittent organ of *G. berlandieri* (left) and of *G. agassizi*.

Note the near equality of head size of two mature males of substantially different body size (carapace of *G. berlandieri* 176 mm. long; that of *G. agassizi* 220 mm. long). The single intromittent organs differ principally in pigmentation.

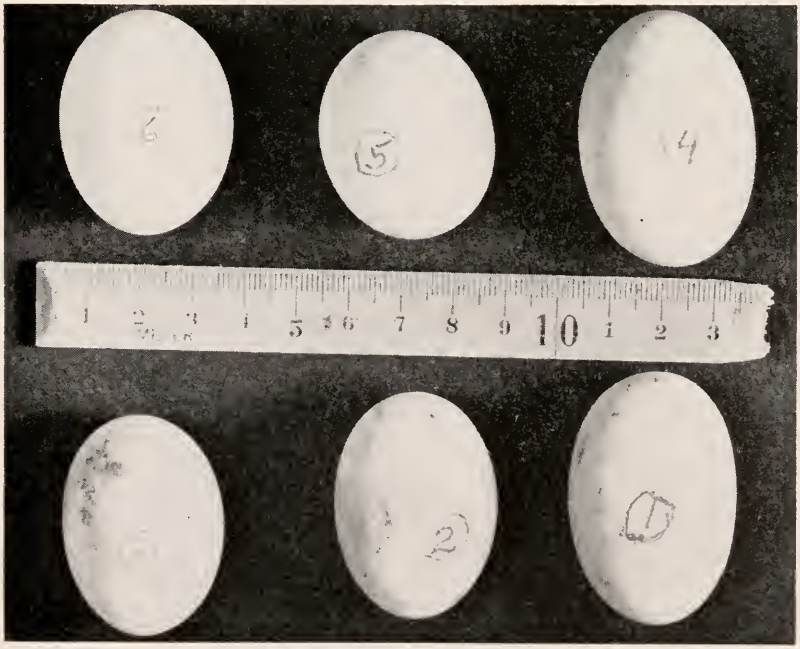

FIG. 2. Eggs of *Gopherus berlandieri*, laid in captivity, June and July 1960.

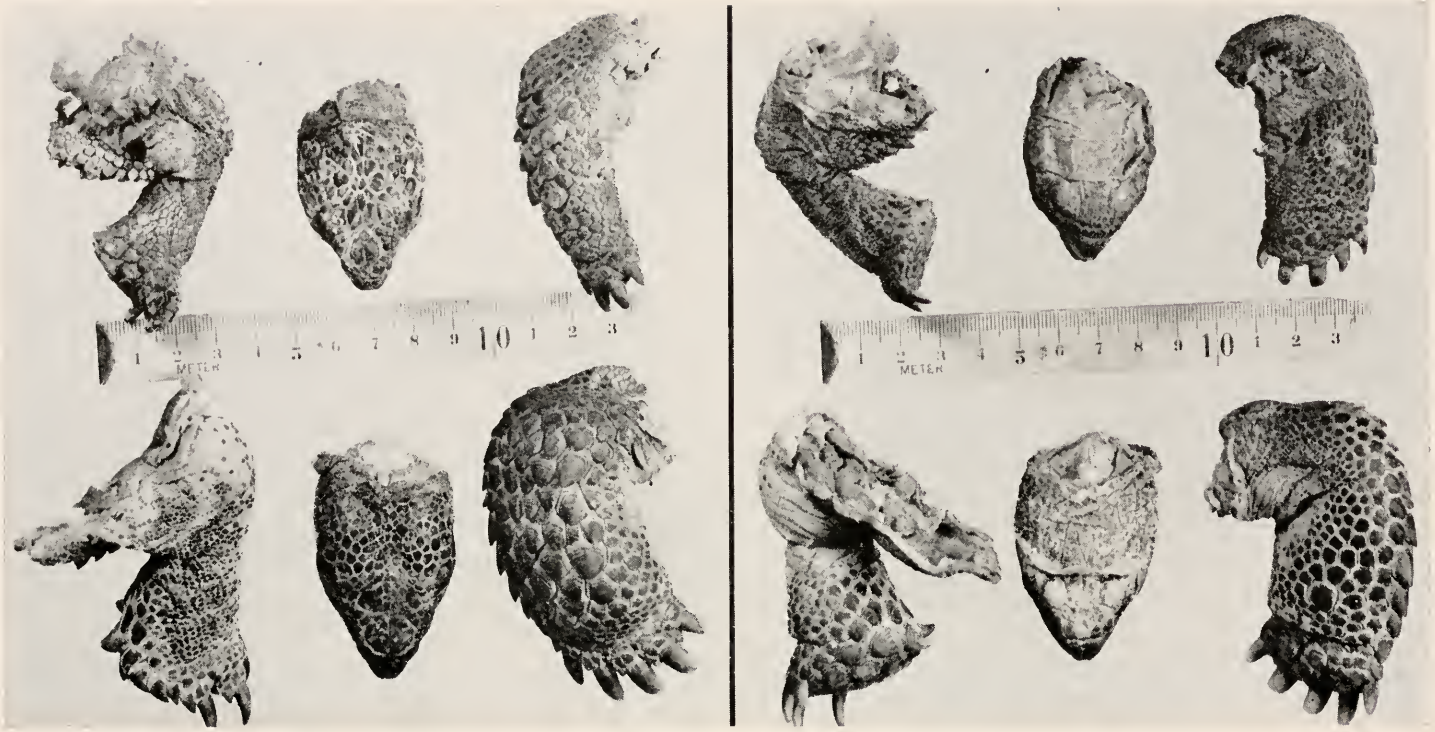

Fig. 3 (left). Top view of hind leg, head, and right foreleg, of *Gopherus berlandieri* (above) and of *G. agassizi*.

Note the pointed snout, the fewer and larger keeled scales on the outer surface of the foreleg, and the fewer heel spines on the hind foot of *G. berlandieri*.

Fig. 4. Lower view of hind leg, head, and right foreleg, of *Gopherus berlandieri* (above) and of *G. agassizi*.

Note the scent glands at the bulbs of the jaw. Also note the large pointed scales high up on the relatively narrow foreleg of *G. berlandieri* and the single flat enlarged scale near the forefoot of *G. agassizi* and the relatively wide foreleg, adapted to burrowing.

From experiments with available plants and vegetables, it appears that red hibiscus flowers are the first choice; next are the green pods of black-eyed peas or string beans, next the fruit of *Opuntia* when red-ripe, next the pads of spineless *Opuntia* or the tender pads of spiny *Opuntia*. Sparingly eaten are red or pink canna blossoms, purple iris blossoms, and apples. The apples are more readily eaten if dyed red, but will finally be consumed even after they have dried to a brown morsel. Apparently the smell of dried apple is more pleasing than that of fresh apple. Apples must be quartered, for the tortoise cannot bite or hold a whole one. Slices of fresh onion dyed red are smelled, tasted, and rejected: apparently the smell is not offensive, but the taste is. Lettuce and green cabbage are rejected, but red cabbage or cabbage or lettuce dyed red are sparingly eaten. They struggle to eat the sweet coarsely fibrous covering of the seeds of the queen palm (*Arecastrum romanzoffianum*). Watermelon, beets, red roses, fuchsias, red plums, red beef, white bread dyed red, cantaloupe unless dyed red, all were ignored. When the red is eaten off a red-dyed cantaloupe or banana, they become less attractive. Brushing food that is not particularly liked with vanilla extract had no effect. Frequently when an animal is not eating normally, it can be induced to eat its usual foods if these are flavored with vanilla.

Experiments were made in the dark with an ordinary electric bulb. The tortoises moved about slowly a couple of feet beyond the lighted area and then returned. With a red bulb the reactions were the same except that white straws etc., appearing bright red, were closely inspected, probably as potential food.

DEATH BY DIRECT INSOLATION

On July 20, 1960, a healthy male of *G. berlandieri* was exposed to direct sun in a carton 12 inches deep. It hurried around inside the carton with great agitation for ten minutes and then stopped with its head in a two-inch strip of shade. The temperature in the shade adjacent to the carton was 103 degrees F. Twenty minutes later it was dead and rigid, and it may have died immediately after coming to a halt. The remaining tortoises, in the shade at 103 degrees F., were not affected.

BEHAVIOR IN CAPTIVITY

The Texas tortoise seems more sensitive to the sun than is *G. agassizi*, as shown by its endeavor to get into shade. Its activity is limited to short periods in the morning and afternoon during optimum temperature and light conditions. Doubtless these periods would be longer in the field if the animal were hungry, but captives do not eat daily, sometimes skipping two days. It is more sensitive to darkness than are chickens and immobilizes while there is still light enough for a person to read a newspaper. The spot or corner selected to spend the night is usually the same for the various individuals. If moved from the selected spot after dark, some will make a blundering effort to move, whereas others will spend the remainder of the night where placed.

Digging seems to be of two kinds. They can squirm down into the soil, aided by the recurved marginals which act like little plows, lifting the dirt

upwards; or they burrow, flicking the dirt out with the forefeet and pushing it out with the hind feet.

Apparently undesired grass and twigs are eaten because the tortoise is unable to discard them because of its clumsiness.

While climbing in attempting to escape or find shelter, the Texas tortoise may frequently fall wrong-side-up. Because of the domed carapace, it is usually somewhat tilted to one side. The first act is usually to urinate and then lie quietly for some seconds. Then the snout is pressed against the ground; the upper foreleg is flailed to overcome inertia so as to rotate the body towards the snout. The lower foreleg can then be moved next to the snout, and the lower hind leg is used to pry the body over.

No attempts to mate were seen although the temperature was in the 90's F. for a week in July and then up to 104 the following week and in the 90's the last week of July. They were penned outdoors with shelter and water but were not seen to drink.

Care in Captivity

Many captive desert tortoises have died because of unfavorable conditions. They will not eat except in broad daylight and at an optimum temperature of from about 80 to 90 degrees F. Food that can be bitten off of larger pieces is preferable to chopped food. Lettuce and apples are not a whole food, whereas green string beans, the pads of *Opuntia ficus-indica*, and the fruit of any *Opuntia*, are whole foods and readily eaten. Some other fruits and vegetables are eaten if dyed red with an odorless tasteless vegetable dye, which may be applied with a pastry brush. Captive tortoises must have shade, and they must be supplied with water unless *Opuntia* or other succulent food is eaten. They must also be allowed to burrow or furnished with low shelter.

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MARINE MOLLUSKS FROM LOS ANGELES BAY, GULF OF CALIFORNIA

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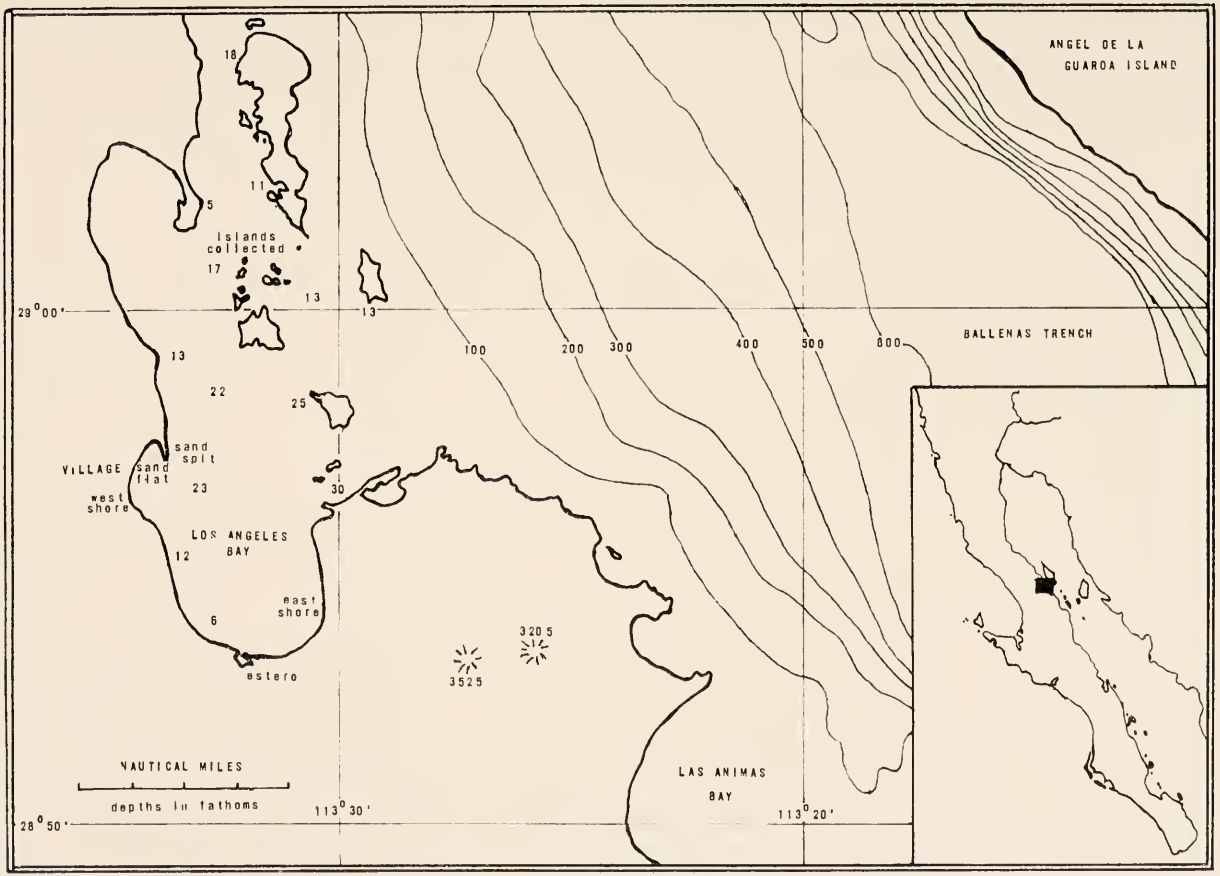

FIG. 1. Area of Los Angeles Bay; inset showing the location of this area in Baja California.
(Partly after Shepard 1950, chart 3.)

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MARINE MOLLUSKS FROM LOS ANGELES BAY, GULF OF CALIFORNIA

BY

James H. McLean

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Introduction

Los Angeles Bay, Baja California, is on the west shore of the Gulf of California at 29 degrees north latitude and thus about 275 miles south of the California boundary (fig. 1). Although several small collections of mollusks have been reported from this part of the Gulf, no extensive list is published. Now two large collections and three small ones make possible a preliminary check list. Though doubtless incomplete, this list probably includes at least all the common species. It is offered as a working list for use at the new Vermilion Sea Field Station, of the San Diego Museum of Natural History, at Los Angeles Bay. Furthermore, it includes several interesting range extensions.

Mrs. Faye Howard of Pacific Palisades, California, collected mollusks at Los Angeles Bay on September 9 and 10, 1957, and from February 22 to April 2, 1960. Her collection of 362 species is the main basis for the list. Also, from June 9 to 12, 1960, I collected 156 species of mollusks. Several people have contributed identifications: Dr. A. Myra Keen, most of the small pelecypods; Dr. S. Stillman Berry, Caecidae, chitons; Dr. William K. Emerson, scaphopods; Dr. Leo G. Hertlein, brachiopods and some gastropods; and Mr. Allyn G. Smith, additional chitons. A small collection by Miss Josephine Scripps and one by Mr. Wesley Farmer, both identified by Mr. Emery P. Chace, also are included in the report, and likewise a small collection by Mr. Robert Martin, identified by Dr. S. Stillman Berry.

PREVIOUS COLLECTING IN THE LOS ANGELES BAY AREA

Nine records of molluscan collecting in the vicinity of Los Angeles Bay appear in the literature. (1) The "Albatross" voyage of 1911 reported by Townsend (1916) collected mollusks at Angel de la Guarda Island. (2) Oldroyd (1918) described *Acanthina angelica* and recorded 46 other species of mollusks from Angel de la Guarda Island. (3) The 1921 expedition of the California Academy of Sciences to the Gulf of California dredged in Los Angeles Bay. The type of *Haminoea angelensis* was taken then. A general account of this expedition was given by Slevin (1923). (4) The Second Bingham Oceanographic Expedition to the Gulf of California dredged in Los Angeles Bay in 1926. Boone (1928) listed 16 species of mollusks found at that time. (5) Lowe (1935) described two species from Los Angeles Bay, *Calliostoma angelenum* and *Clavus pembertoni*, which he collected there in 1933. (6) The Hancock Pacific Expeditions of 1936 and 1937 both visited Los Angeles Bay. Fraser (1943) listed five dredging stations and three shore stations, but the mollusks have not been reported. (7) Steinbeck and Ricketts visited Los Angeles Bay on their collecting cruise of 1940. They concentrated on shore collecting of invertebrates, and mentioned 28 common species of mollusks from Los Angeles Bay in their *Sea of Cortez* (1941). (8) Emerson and Puffer (1957) reviewed collections made on the *E. W. Scripps* cruise of 1940 and reported 26 species from Angel de la Guarda Island, 12 species dredged in the Ballenas Trench west of the island, and 66 species from Las Animas Bay, to the southeast of Los Angeles Bay. (9) The 1957 Puritan-American Museum of Natural History Expedition to Western Mexico collected at the south and north ends of Angel de la Guarda Island. A general account of this expedition was given by Emerson (1958).

OCEANOGRAPHIC CONSIDERATIONS

Los Angeles Bay has an area of about 25 square miles. It is protected at the entrance by several small islands (fig. 1). Angel de la Guarda Island, the second largest island in the Gulf, lies east of the Bay, approximately 20 miles off shore. The Gulf sea-floor outside the Bay slopes gradually to a depth of over 600 fathoms in the Ballenas Trench, then rises abruptly to Angel de la Guarda Island, which reaches an elevation of 4315 feet (Anderson 1950). The 600-fathom basin of the Ballenas Trench is isolated from other areas of similar depth by bottom of less than 200 fathoms.

Unusual hydrographic conditions are found in the Los Angeles Bay area. Roden and Groves (1959, p. 11) reported:

> One of the outstanding features of the Gulf of California is the large annual range of sea surface temperatures; at Puerto Peñasco in the north the range is about 16°C; at Cabo San Lucas in the south it is about 9°C . . . An interesting feature is an area of low temperatures around Isla Angel de la Guarda which is found throughout the year. Along the coast, temperatures are somewhat dependent upon upwelling; in winter low temperatures are generally found along the east coast and in summer along the west coast.

Unfortunately, no year-around temperature data are available, but upwelling is known to occur in the area of Los Angeles Bay and Angel de la Guarda Island. During June the water was so cold that I needed a rubber suit for skin-diving.

The tidal range in the vicinity of Los Angeles Bay is about three meters. The tides are characterized by diurnal inequality, i.e. successive high tides are markedly unequal and likewise successive low tides. Tidal currents of six knots have been reported in the Ballenas Strait (Roden and Groves 1959).

During my stay at Los Angeles Bay in early June, a "red tide" plankton bloom was present in front of the village but not around the small islands. The organism was not a dinoflagellate such as causes red tides in southern California but had the appearance of an unbranched red filament, just visible without magnification. Dr. E. Yale Dawson, the algal specialist to whom I wrote, suggested that it was "probably the cyanophyte that gave rise to the name of 'Vermilion Sea' for the Gulf of California in the days of Coronado." Where it occurred in high concentrations, the water was rust-red and slimy to the touch. This condition had prevailed in the bay during most of May. My attempts to preserve specimens in alcohol were unsuccessful because the filaments disintegrated. Unlike the dinoflagellate red tides, this planktonic bloom did not seem to have any detrimental effects on fish or invertebrates. The field station will provide an opportunity to investigate this phenomenon when it occurs again.

Description of the Collecting Areas

The rocky area in front of the field station (fig. 3) was collected intensively. The most abundant of the mollusks found there are listed in table 1. Inasmuch as wave action and the effect of tidal currents are slight, the substrate surrounding the rocks is muddy, and the assemblage therefore includes some forms typical of a restricted bay environment as well as others more typical of the open coast.

Steinbeck and Ricketts (1941, pp. 220, 221) mentioned some of the invertebrates they collected at this spot and gave additional records in the appendix to their book. My identifications of invertebrates other than mollusca are based upon their photographs, records, and descriptions.

At highest tides the stone wall in front of the station is covered by water, but the rocks of this wall are barren. The lowermost stones of the wall, and the boulders below, support the large barnacle *Tetraclita squamosa stalactifera* (Lamarck) and the smaller barnacle *Chthamalus anisopoma* Pilsbry, among which oysters and limpets are found. Three species of mollusks occur in great numbers under rocks. A large rock I overturned had under it about 60 individuals of the pulmonate *Onchidella binneyi*, 30 of the chiton *Acanthochitona exquisita*, and 25 of the gastropod *Acanthina angelica*.

A black holothurian is conspicuous under rocks exposed by the higher of the low tides. The lowest tides expose a much greater profusion of life. Algae are noticeable only at the lowest levels, especially a brown alga with fan-shaped blades, *Padina durvillaei* Bory, and a green alga, *Codium cuneatum* Setchell and Gardner. Most noticeable at the lowest tides is a large red sponge, colonies of

TABLE 1. Mollusks abundant on rocks in front of the field station

EXPOSED AT MID-TIDE:	
Chiton	
Acanthochitona exquisita	under sides of rocks
Gastropods	
Acmaea mitella fayae	among barnacles
A. turveri	" "
Acanthina angelica	" "
Onchidella binneyi	under rocks
Pelecypods	
Hormomya adamsiana	attached among barnacles
Ostrea conchaphila	" " "
O. palmula	" " "
EXPOSED AT BOTH LOW TIDES:	
Gastropods	
Cerithium sculptum	on sand near rocks
Mitrella ocellata	" " " "
Acmaea strongiana	on rocks
Nomaeopelta dalliana	" "
Tegula mariana	" "
Pelecypods	
Arcopsis solida	attached to under-surfaces of rocks
Cardita affinis	" " " " "
Isognomon chemnitzianus	" " " " "
EXPOSED ONLY AT THE LOWER LOW TIDES:	
Gastropods	
Crassispira nymphia	exposed on, or under, rocks
Fusinus cinereus	" " " " "
Morula ferruginosa	" " " " "
Pyrene fuscata	" " " " "
Turbo fluctuosus	" " " " "
Strombina maculosa	" " " " "
Crucibulum spinosum	always under rocks
Cypraea annettae	" " "
Diodora alta	" " "
D. digueti	" " "
D. inaequalis	" " "
Marginella californica	" " "
Mitra solitaria	" " "
Serpulorbis margaritaceus	attached to sides of rocks

which reach a foot in diameter. Under rocks will be found a black sea urchin, *Arbacia incisa* A. Agassiz, a many-rayed star, *Heliaster kubiniji* Xantus, and numerous brittle stars, sponges, and tunicates. *Octopus bimaculatus* may be encountered among rocks underwater. The depth of the water increases gradually, but I could not explore the subtidal area because of the red tide.

Mrs. Howard collected on the east shore of the bay, where she reported that the intertidal zone is steeper than on the west side and surf and tidal action are stronger. The molluscan assemblage is typical of a more exposed coast. *Tegula rugosa,* an abundant north Gulf gastropod, occurs there in large numbers though not in the more protected environment of the bay.

Just north of the station and in front of the village, the lowest tides expose a flat of muddy sand below the beach. This flat increases in width toward the sandspit to the north. The dominant animals of the flat are the sand dollars *Encope grandis* L. Agassiz and *Encope californica* Verrill. They are found buried just under the surface of sand or exposed in such numbers that they may cover entire areas. Two or three commensal crabs, *Dissodactylus* sp., were usually found with each sand dollar. Such a high concentration of sand dollars may discourage burrowing pelecypods. The gastropods *Nassarius tiarula* and, in lesser numbers, *N. moestus* occur on the sand surface by the thousands. The large gastropod *Terebra variegata* moves just below the surface of the sand. On the sandspit, cobbles and small rocks support some rock-living forms.

The small islands are separated from shore by water 10 to 25 fathoms deep (fig. 1). The intertidal zone on the islands is steep and, except for a few gravel beaches, is composed entirely of small boulders (fig. 2). At low tide level, the alga *Padina durvillaei* Bory grows more luxuriantly than on the rocks in front of the station. Around the islands, a *Sargassum* with dense branches is anchored to the subtidal rocks within several yards of shore, forming the equivalent of a kelp bed.

Subtidally, the long-spined urchin *Centrostephanus coronatus* (Verrill) practically fills the rock crevices, and the diver must avoid its sharp spines. The coral *Porites californica* Verrill (see Squires 1959) forms extensive green encrustations and pinnacles on the rocks, and encrusting red coralline algae cover large areas of rock surfaces. A specimen of the large pecten *Lyropecten subnodosus,* loosely attached by byssal threads, was encountered. The jingle oyster *Pododesmus pernoides* thrives on the upper surfaces of boulders. Under surfaces of rocks yielded many specimens of the limpet *Acmaea semirubida.* SCUBA diving at greater depths should prove rewarding.

Faunal Relationships

This check list records 405 species of mollusks, of which 135 are pelecypods, 248 are gastropods, 3 are scaphopods, and 19 are chitons. Of this number, 16 are doubtfully identified ("cf.") and 34 are identified only by genus. I hope to describe some of the new species in a later paper.

Twenty-four species collected at Los Angeles Bay appear to be major northward extensions of known range, not to my knowledge having been reported from the Gulf of California or from north of Mazatlan (range data from Keen 1958). These are: *Pseudochama corrugata, P. panamensis, Mactra fonsecana, Apolymetis cognata, Tagelus bourgeoisae, Arene hindsiana, Balcis gibba, Opalia diadema, Cyclostremiscus panamensis, Solariorbis elegans, S. narinensis, Teinostoma* cf. *T. herbertianum, Rissoina io, Heliacus mazatlanicus, Serpulorbis mar-*

garitaceus, Eupleura nitida, Mitrella delicata, Nassarina pammicra, Mitra erythrogramma, Crassispira atramentosa, Mangelia phyrne, Turricula dolenta, T. howelli, and *Placiphorella blainvillei.* The northernmost locality previously known for each of these is mentioned in the checklist. Four species collected at Los Angeles Bay appear to be southward extensions of known range, occurring in the California region but not to my knowledge reported before from the Gulf. These are: *Macoma indentata, Balcis rutila, Leptochiton cancellatus,* and *Lepidochitona keepiana.*

The molluscan fauna is Panamic in its affinities. The northern Gulf, however, supports some members of the Californian province. The following species with ranges centered in the Californian province occur at Los Angeles Bay (range data from Keen 1937): *Aequipecten latiaurata, Transenella tantilla, Cooperella subdiaphana, Macoma indentata, Cryptomya californica, Corbula luteola, Tegula ligulata, Balcis rutila, Metaxia diadema, Polinices reclusianus, Trivia californiana, Cypraeolina pyriformis, Mangelia barbarensis, Melampus olivaceus, Williamia peltoides, Leptochiton cancellatus,* and *Lepidochitona keepiana.* Some of these species may be isolated in the north end of the Gulf, while others may eventually be shown to occur along the entire Baja California peninsula and throughout the Gulf. None are to be expected south of Mazatlan. Many other species, as for example, *Chione californiensis,* are found in southern California and the Gulf but range well into the Panamic province (see Hertlein and Emerson 1956).

More striking than the presence of these northern elements is the apparent absence of a considerable number of species common on the eastern shore of the Gulf. The following larger gastropods, not known at Los Angeles Bay, I have collected at either Guaymas or Puerto Peñasco, or both: *Astrea unguis, Turritella gonostoma, Cypraea arabicula, Thais biserialis, T. speciosa, T. triangularis, Purpura patula pansa, Anachis varia, Parametaria dupontii, Pyrene haemostoma, P. major, Cantharus sanguinolentus, Conus brunneus, C. nux, C. perplexus, C. princeps, C. purpurascens,* and *C. virgatus.* Many of these species occur on the west side of the Gulf to the south, for example at San Marcos Island (Emerson and Puffer 1957). Some of them occur at least sporadically to the north: Mrs. Howard tells me that *Anachis varia* and *Conus perplexus* occur at San Felipe, *Parametaria dupontii* at Puertocitos, *Conus nux* and *C. princeps* at San Luis Gonzaga Bay. Additional collecting is needed to show whether all these species actually are absent from the Los Angeles Bay area and, if so, whether they are absent also along most of the northwestern Gulf coast. Adequate temperature data are not available to demonstrate that the absence of these species at Los Angeles Bay can be accounted for by year-around cool temperatures maintained by upwelling, particularly in the summer. Their exclusion could result from failure of the area to reach temperatures necessary for reproduction.

Less well known is a faunal element that appears to be restricted to the extreme northern and northwestern shores of the Gulf. Species in this category that are common at Los Angeles Bay but rare or absent at Guaymas on the eastern shore include *Acmaea strongiana, Nomaeopelta dalliana, Acanthina angelica, Crassispira nymphia,* and *Acanthochitona exquisita.*

Systematic Account

The nomenclature and the order in the checklist follow Keen (1958) except that the arrangement of the chitons follows Smith (1960). Most of the species are illustrated in Keen's book; and illustrations of the minute-shelled species, which she omitted, may be located through her bibliography. The dates of description of species are given only for those species that she did not include.

The collecting stations referred to in the list (west shore rocks, sand flat, sandspit, east shore rocks, estero, islands) are shown on the map (fig. 1). The collector's initial is given in parentheses: B for a collection made by Mr. Robert Martin in April 1957, now in the collection of Dr. S. Stillman Berry; F for a collection made by Mr. Wesley Farmer in April 1960; H for Mrs. Howard's collection made September 9 and 10, 1957, and February 22 to April 2, 1960; M for the writer's collection, June 9 to 12, 1960; S for the collection made by Miss Josephine Scripps in March 1960. The Farmer (F) and Scripps (S) collections are in the San Diego Museum of Natural History. Los Angeles Bay records of Boone (1928) and Steinbeck and Ricketts (1941) have been included for the few species of their lists not otherwise recorded.

Twenty-three of Mrs. Howard's records cited as "on *Spondylus*" were taken from 18 shells of *Spondylus princeps*, presumably from relatively deep water, which she obtained from a local fisherman. A large number of species are reported only "from drift". These minute shells, deposited on the far end of the sandspit by the outgoing tide, were laboriously sorted by Mrs. Howard. The species referred to as beach and drift shells were not found living by us. Many of these live in deeper water according to the bathymetric ranges given by Keen (1958). Little attempt has been made to indicate relative abundance, except for the mention of common and scarce species. All live-collected specimens were taken at low tide unless indicated otherwise.

Class Pelecypoda

Nuculidae

Nucula cf. *N. declivis* Hinds. Worn valves from drift (H).
Nucula cf. *N. linki* Dall. A fragment from drift (H).

Arcidae

Arca (Arca) mutabilis (Sowerby). East shore under rocks (H).
Arca (Arca) pacifica (Sowerby). East shore under rocks (H).
Barbatia (Barbatia) lurida (Sowerby). Attached to under surfaces of large rocks (M).
Barbatia (Acar) gradata (Broderip and Sowerby). Under rocks (H).
Barbatia (Cucullaearca) reeveana (Orbigny). West shore under rocks (H).
Barbatia (Fugleria) illota (Sowerby). Under large rocks (H,F).
Arcopsis solida (Sowerby). Abundant on undersurfaces of rocks (H,M,F).
Anadara (Larkinia) multicostata (Sowerby). Half buried in sand (H,M).
Anadara (Scapharca) cepoides (Reeve). Just under surface of sand on sandspit (H).

Glycymeridae

Glycymeris (Glycymeris) bicolor (Reeve). Fresh valves on sandflat (H).
Glycymeris (Glycymeris) gigantea (Reeve). Living on side in sand near rocks (H,M).
Glycymeris (Glycymeris) maculata (Broderip). Just below surface of coarse sand (H,M).
Glycymeris (Glycymeris) multicostata (Sowerby). Just below surface of sand (H,M).

Mytilidae

Brachiodontes multiformis (Carpenter). On rocks among barnacles (H,M).
Hormomya adamsiana (Dunker). Abundant at mid-tide level among oysters and large barnacles (H,M).
Crenella divaricata (Orbigny). Valves from drift (H).
Lithophaga (Microforceps) aristata (Dillwyn). Boring in vermetids and nestling among barnacles (H,M,B).
Lithophaga (Labis) attenuata rogersi Berry. Living in worm tubes (H).
Lithophaga (Leiosolenus) spatiosa (Carpenter). Valves from drift (H).
Gregariella cf. *G. chenui* (Recluz). On *Spondylus* (H).
Modiolus capax (Conrad). Exposed among rocks and cobbles (H,M,F,S,B).

Pteriidae

Pteria sterna (Gould). Fresh valves on outer side of sandspit; living attached to gorgonians (H,F).

Pinnidae

Pinna rugosa (Sowerby). Anchored in sand among rocks on outer side of sandspit and on east shore (H,M,F).
Atrina tuberculosa (Sowerby). In sand near rocks, especially on east shore (H,M,F).

Isognomonidae

Isognomon (Melina) chemnitzianus (Orbigny). Common attached to undersurfaces of rocks, low to mid-tide levels (H,M).
Isognomon (Melina) janus Carpenter. Under rocks; less common (H,M,F).

Ostreidae

Ostrea angelica Rochebrune. East shore, on cobbles (H).
Ostrea columbiensis Hanley. Valves on beach (H).
Ostrea conchaphila Carpenter. Common attached to rock among small barnacles at mid-tide level (H,M).
Ostrea fisheri Dall. Valves from islands (H,M).
Ostrea palmula Carpenter. Common in bay, exposed on rocks at mid-tide level (H,M,B).

Pectinidae

Pecten vogdesi Arnold. Valves common on beach (H,M).
Aequipecten (Plagioctenium) circularis (Sowerby). Valves on beach (H,M).
Aequipecten (Leptopecten) latiauratus (Conrad, 1837). One specimen attached to *Spondylus* (H).
Cyclopecten pernomus (Hertlein). Valves in drift (H).
Lyropecten (Lyropecten) subnodosus (Sowerby). Valves on beach; living subtidally near islands (H,M,F,S).

Limidae

Lima (Lima) tetrica Gould. One juvenile from islands (M).
Lima (Limaria) hemphilli Hertlein and Strong. Valves (H).
Lima (Promantellum) pacifica Orbigny. Valves (M).

Spondylidae

Spondylus princeps Broderip. Subtidally from islands (H).
Spondylus calcifer Carpenter. Large rocks on islands at low tide level (H).
Plicatula spondylopsis Rochebrune. Attached to rocks, west shore (M).

Anomiidae

Anomia adamas Gray. Plentiful on cobbles outside sandspit (H).
Anomia peruviana Orbigny. On cobbles outside sandspit (H,M,F,S).
Pododesmus cepio (Gray). Common on rocks and pelecypod valves (H,M).
Pododesmus (Tedinia) pernoides (Gray). Large specimens on subtidal boulders off islands. (M).
Placunanomia cumingii Broderip. Valves from sandspit (H).

Crassatellidae

Crassatella (Hybolophus) digueti Lamy. Valves, east shore (H).
Crassinella pacifica (C. B. Adams). Valves, with *Spondylus* (H).

Carditidae

Cardita affinis Sowerby. Under rocks (H).
Cardita affinis var. *californica* Deshayes. Abundant under rocks in bay (H,M,F).

Lucinidae

Lucina (Bellucina) cancellaris Philippi. Valves from drift (H).
Lucina (Callucina) lampra (Dall). Valves from drift (H).
Lucina (Parvilucina) approximata (Dall). Valves from drift (H).
Anadontia edentuloides (Verrill). Valves (H,M).
Codakia distinguenda (Tryon). Valves (H,M).
Ctena mexicana (Dall). One valve from drift (H).
Divalinga eburnea (Reeve). Valves (H,M).

DIPLODONTIDAE

Diplodonta (Diplodonta) inezensis (Hertlein and Strong). Valves (H).
Diplodonta (Diplondonta) orbellus (Gould). Nestling among rocks (H,M).
Diplodonta (Diplodonta) subquadrata (Carpenter). Nestling on east shore among rocks (H).
Diplodonta (Felaniella) sericata (Reeve). Valves (H,M,F).

ERYCINIDAE

Aligena cokeri Dall. Valves from drift (H).
Aligena nucea Dall. Valves from drift (H).
Basterotia peninsularis Jordan. Valves from drift (H).
Galeomma mexicanum Berry, 1959. Valves from drift (H).
Kellia suborbicularis (Montagu). Juveniles nestling on *Spondylus* (H).
Mysella cf. *M. compressa* (Dall). Valves from drift (H).
Solecardia eburnea Conrad. Valves (H).

CHAMIDAE

Chama buddiana C. B. Adams. On rocks north of sandspit (H,F).
Chama frondosa mexicana Carpenter. East shore (H). Known range extended north from La Paz.
Chama sordida Broderip. A large specimen on *Spondylus* (H).
Chama squamuligera Pilsbry and Lowe. Juveniles on *Spondylus;* adults from east shore (H).
Pseudochama corrugata (Broderip). On rocks, east shore (H). Known range extended north from southern Mexico.
Pseudochama panamensis (Reeve). On cobbles, east shore (H). Known range extended north from Panama.
Pseudochama saavedrai Hertlein and Strong. Common on rocks of west shore (M).

CARDIIDAE

Trachycardium (Trachycardium) consors (Sowerby). Just under sand on sandspit (H,M).
Trachycardium (Mexicardia) panamense (Sowerby). Just under sand inside sandspit (H).
Papyridea aspersa (Sowerby). Valves common (H,M).
Trigonicardia (Trigonicardia) granulifera (Broderip and Sowerby). Valves with *Spondylus* (H).
Trigonicardia (Americardia) biangulata (Broderip and Sowerby). Just under sand on sandflat (H).
Laevicardium clarionense (Hertlein and Strong). Just under sand on sandflat (H).
Laevicardium elatum (Sowerby). Fresh valves on sandflat (H).
Laevicardium elenense (Sowerby). Just under sand on sandflat (H,M).
Laevicardium elenense var. *apicinum* (Carpenter). Just under sand on sandflat (H).
Nemocardium (Microcardium) pazianum (Dall). Valves with *Spondylus* (H).

Veneridae

Periglypta multicostata (Sowerby). Valves from midden (H).

Gouldia californica Dall. Valves in drift and on *Spondylus* (H). Known range extended north from La Paz.

Transennella tantilla (Gould). Common in drift (H).

Pitar (Pitar) newcombianus (Gabb). Just under surface of sand (H).

Megapitaria squalida (Sowerby). Just under surface of sand on sandflat (H).

Dosinia ponderosa (Gray). Living below surface on sandflat (H,M).

Chione (Chione) californiensis (Broderip). Among rocks (H,M).

Chione (Chione) undatella (Sowerby). Among rocks (H,M).

Chione (Chionista) cortezi (Carpenter). Valves (H).

Chione (Timoclea) picta Willet. Valves (H).

Anomalocardia subimbricata (Sowerby). Valves (S). Known range extended north from La Paz.

Anomalocardia tumens (Verrill). Valves common on islands (H,M).

Protothaca grata (Say). Abundant on sand, near rocks (H,M,F,S).

Protothaca (Leukoma) asperrima (Sowerby). Valves (H,M).

Petricolidae

Petricola (Rupellaria) robusta Sowerby. Valves (H).

Cooperellidae

Cooperella subdiaphana (Carpenter). Valves from drift (H).

Mactridae

Mactra (Mactrotoma) dolabriformis (Conrad). One valve (H).

Mactra (Micromactra) fonsecana Hertlein and Strong. Valves (H). Known range extended north from Nicaragua.

Anatina (Raëta) undulata (Gould). Valves (H,M).

Mulinia coloradoënsis Dall. Valves (H).

Tellinidae

Tellina (Merisca) reclusa Dall. Valves (H).

Tellina sp. Abundant in drift (H). A small tellin to be described by Dr. Myra Keen.

Apolymetis cognata (Pilsbry and Vanatta). One valve (H). Known range extended north from Nicaragua.

Macoma indentata Carpenter, 1866. Valves common on sandflat (H,M). Known range extended south into the Gulf.

Strigilla cicercula (Philippi). Valves (S).

Strigilla costulifera (Mörch). Valves (H).

SANGUINOLARIIDAE

Gari (Psammocola) regularis (Carpenter). Valves on sandflat (H).
Heterodonax bimaculatus (Linnaeus). Abundant in gravel, especially on islands, low to mid-tide levels (H,M,S).
Tagelus (Tagelus) californianus (Conrad). Valves on sandflat (H,M,F).
Tagelus (Mesopleura) bourgeoisae Hertlein. Valves (H). Known range extended north from Salina Cruz, Mexico.
Tagelus (Mesopleura) peruvianus Pilsbry and Olsson. Valves (H).

SEMELIDAE

Semele bicolor (C. B. Adams). Valves (H).
Semele corrugata californica (Reeve). Valves from islands (M).
Semele flavescens (Gould). Valves (H,M).
Semele guaymasensis Pilsbry and Lowe. Valves (H).
Semele jaramija Pilsbry and Olsson. One valve from drift (H). Second record for this species.
Abra tepocana Dall. Valves with *Spondylus* (H).
Cumingia lamellosa Sowerby. Valves from drift (H).

MYACIDAE

Cryptomya californica (Conrad). Valves (H).

CORBULIDAE

Corbula (Caryocorbula) luteola Carpenter. Under rocks (H,M).
Corbula (Tenuicorbula) fragilis Hinds. With *Spondylus* (H).

GASTROCHAENIDAE

Gastrochaena ovata Sowerby. Valves from drift (H).

HIATELLIDAE

Hiatella arctica (Linnaeus). Nestling under rocks (H,M).

LYONSIIDAE

Lyonsia (Lyonsia) gouldii Dall. Just under surface of sand (H).
Lyonsia (Phlycticoncha) lucasana Bartsch and Rehder. Valves (H).

THRACIIDAE

Thracia squamosa Carpenter. One valve (H).
Cythodonta lucasana Dall. One valve (H).

Class SCAPHOPODA

DENTALIIDAE

Dentalium (Graptacme) sp. Fragments from drift (H).
Dentalium (Tesseracme) quadrangulare Sowerby. Specimens from drift (H).

SIPHONODENTALIIDAE

Cadulus sp. Fragments from drift (H).

Class Gastropoda

Acmaeidae

Acmaea atrata Carpenter. One specimen from drift (H).

Acmaea mitella fayae Hertlein. Among small barnacles at mid-tide level (H,M).

Acmaea pediculus (Philippi). Uncommon, immediate subtidal level on islands (M).

Acmaea semirubida Dall. Abundant on under side of subtidal rocks off islands (H,M).

Acmaea strongiana Hertlein. Abundant on and under rocks at mid-tide level (H,M).

Acmaea turveri Hertlein and Strong. Among small barnacles at mid-tide level (H,M).

Nomaeopelta dalliana (Pilsbry). Bay and island rocks, buried in sand during the day (H,M,F,S,B).

Nomaeopelta mesoleuca (Menke). East shore rocks (H). This may be separable from the southern form.

Nomaeopelta stanfordiana (Berry). Mid-tide level, east shore rocks (H).

Fissurellidae

Fissurella rugosa Sowerby. Specimens from drift (H,M).

Diodora alta (C. B. Adams). Common under rocks in bay (H,M).

Diodora constantiae Kanakoff, 1953. Shells in drift (H).

Diodora inaequalis (Sowerby). Under rocks in bay (H,M). The aperture is elongate and shows black mantle tissue and an epipodium mottled with brown.

Diodora digueti (Mabille). Under rocks in bay (H,M). The aperture is oval and shows light-colored tissue. The epipodium is gray with small brown spots.

Hemitoma (Montfortia) hermosa Lowe. A juvenile specimen from drift (H).

Trochidae

Calliostoma angelenum Lowe. Uncommon at low-tide level and subtidally (H,M).

Calliostoma eximium (Reeve). Partially buried on sandflat (H).

Calliostoma marshalli Lowe. Under rocks outside sandspit (H).

Tegula (Agathistoma) ligulata (Menke). Small specimens under rocks (H,M,S).

Tegula (Agathistoma) mariana Dall. Common under rocks (H,M,F,S).

Tegula (Omphalius) rugosa (A. Adams). Abundant on rocks of east shore (H,M).

Solariella triplostephanus Dall. One small specimen from drift (H).

Turbinidae

Turbo fluctuosus Wood. Common under and on rocks (H,M).
Turbo saxosus Wood. On rocks of east shore (H,S).

Liotiidae

Arene hindsiana Pilsbry and Lowe. Two specimens under subtidal rocks on islands (M). Known range extended north from Mazatlan.

Phasianellidae

Tricolia (Eulithidium) substriata (Carpenter, 1864). One specimen from drift (M).
Tricolia cf. *T. (Eulithidium) typica* (Dall, 1908). Specimens from drift (H).

Neritidae

Nerita (Ritena) scabricostata Lamarck. Four specimens; apparently scarce (H).
Nerita (Theliostyla) funiculata Menke. Abundant on rocks at mid-tide level (H,M).
Neritina luteofasciata Miller. On sandflat and in estero (H,M).

Phenacolepadidae

Phenacolepas malonei Vanatta. Specimens from drift (H).
Phenacolepas osculans (C. B. Adams). Under large rocks north of sandspit (H).

Eulimidae

Balcis gibba (de Folin, 1867). Two specimens on *Spondylus* (H). Known range extended north from Panama.
Balcis mexicana (Bartsch, 1917). Two specimens under rocks of west shore (M).
Balcis cf. *B. rutila* (Carpenter, 1856). Four live specimens from sandspit (H). Close to the Californian *B. rutila*.
Balcis, 3 spp. indet. (H;H;H).
Eulima lapazana (Bartsch, 1917). One juvenile on *Spondylus* (H).
Niso hipolitensis Bartsch, 1917. One specimen from drift (H).

Epitoniidae

Epitonium (Nitidiscala) apiculatum Dall. Hermit crab shells (H,M).
Epitonium (Nitidiscala) hexagonum (Sowerby). Specimens from drift (H).
Epitonium (Nitidiscala) oerstedianum Hertlein and Strong. Two specimens from drift (H).
Opalia (Dentiscala) crenimarginata (Dall). East shore (H).
Opalia (Dentiscala) diadema (Sowerby). East shore (H). Known range extended north from Mazatlan.

Littorinidae

Littorina dubiosa C. B. Adams. Common in drift (H,M). Specimens with varying numbers of keels may also be referable to this species.

Vitrinellidae

Cyclostremiscus panamensis (C. B. Adams, 1852). Four specimens from drift (H). Known range extended north from Mazatlan.

Cyclostremiscus sp. Two specimens from drift (H).

Macromphalina sp. Three specimens from *Spondylus* (H).

Solariorbis elegans Pilsbry and Olsson, 1952. Nine specimens (H). Known range extended north from Ecuador.

Solariorbis narinensis Pilsbry and Olsson, 1952. One immature shell (H). Known range extended north from Colombia.

Teinostoma amplectans Carpenter, 1857. Common in drift (H).

Teinostoma cf. *T. herbertianum* Hertlein and Strong, 1951. One specimen (H). Slightly larger than this species described from Costa Rica.

Vitrinella sp. One worn specimen (H).

Rissoidae

Alvania gallegosi Baker, Hanna, and Strong, 1930. One specimen from drift (H).

Alvania lirata (Carpenter, 1856). Abundant in drift (H).

Alvania monserratensis Baker, Hanna, and Strong, 1930. Common in drift (H).

Alvania sp. One specimen from islands (M).

Barleeia alderi (Carpenter, 1856). Common in drift (H,M).

Barleeia subtenuis (Carpenter, 1856). Common under rocks (H,M).

?Diala sp. Five specimens from drift (H).

Rissoina burragei Bartsch, 1915. Abundant in drift; living at low-tide level (H,M).

Rissoina io Bartsch, 1915. One perfect specimen from drift (H). Known range extended north from the Galapagos Islands.

Rissoina, 2 spp. indet. (H;H).

Assimineidae

Assiminea compacta (Carpenter, 1863). Specimens from drift (H).

Truncatellidae

Truncatella bairdiana C. B. Adams, 1852. Four specimens from drift (H).

Turritellidae

Turritella anactor Berry. Shells on beach (H).

Turritella clarionense Hertlein and Strong. One shell on beach (H).

Vermicularia pellucida (Broderip and Sowerby). Abundant, nestled among rocks (H,M).

Architectonicidae

Architectonica nobilis Röding. Shells on beach (H).

Heliacus bicanaliculatus (Valenciennes). On rocks of east shore (H,M).

Heliacus mazatlanicus Pilsbry and Lowe. Specimens from drift (H). Known range extended north from Mazatlan.

Caecadae

Caecum "firmatum" of authors, not of C. B. Adams. Abundant in drift (H). Has no satisfactory name according to Dr. Berry.

Caecum sp. Six juveniles from drift (H).

Elephantanellum heptagonum (Carpenter, 1857). Common in drift (H).

?Elephantulum mirificum (de Folin, 1867). One specimen from drift (H).

Elephantulum ? sp. One juvenile from drift (H).

Modulidae

Modulus cerodes (A. Adams). Subtidally from islands (H,M).

Modulus disculus (Philippi). One hermit crab shell (H).

Vermetidae

Vermetus (Thylaeodus) indentatus (Carpenter). Common on rocks (H,M).

Serpulorbis (Cladopoda) margaritaceus (Chenu). On rocks of west shore (M).

Cerithiidae

Cerithium maculosum Kiener. Shells on beach (H).

Cerithium (Liocerithium) sculptum Sowerby. Common on sand near rocks (H,M,B,S).

Cerithium stercusmuscarum Valenciennes. On sandspit, not common (H).

Cerithiopsis (Cerithiopsida) kinoi Baker, Hanna, and Strong, 1938. Specimens from drift (H).

Cerithiopsis, 3 spp. indet. (H;H;M).

Metaxia diadema Bartsch, 1907. One specimen under rocks of west shore (M).

Seila assimilata (C. B. Adams, 1852). Common under rocks and associated with the large red sponge (H,M).

Alaba interruptilineata Pilsbry and Lowe, 1932. Common in drift (H).

Alaba jeannettae Bartsch, 1910. Specimens from drift (H,M).

Alaba supralirata Carpenter, 1856. Specimens from drift (H).

Triphora cf. *T. evermanni* Baker, 1926. Worn specimens from drift (H).

Triphora, 2 spp. indet. (H;M).

Alabina diomedeae Bartsch, 1911. Very abundant in drift (H). One or more of at least five separable forms may be referred to this species.

Alabina sp. One specimen from drift (H).

Potamididae

Cerithidea albonodosa Gould and Carpenter. At high-tide level on sandflat (H,F).
Cerithidea mazatlanica Carpenter. On sandflat (H,M,F).

Hipponicidae

Hipponix serratus Carpenter. Shells on beach (H,M).

Fossaridae

Fossarus (s.l.) sp. Under rocks of west shore and in drift (H,M).

Calyptraeidae

Cheilea cepacea (Broderip). One specimen on beach (H).
Crepidula aculeata (Gmelin). On *Spondylus* (H).
Crepidula arenata (Broderip). On shells (H,S).
Crepidula excavata (Broderip). On shells (H,M,F).
Crepidula incurva (Broderip). On shells (M).
Crepidula onyx Sowerby. On shells (H,M,S).
Crepidula perforans (Valenciennes). In shell apertures (H,M).
Crepidula uncata Menke. Shells from drift (H).
Crucibulum scutellatum (Wood). On or under rocks in bay (H,M,F).
Crucibulum spinosum (Sowerby). Small specimens common under rocks (H,M,F,S,B).

Naticidae

Natica (Natica) chemnitzii Pfeiffer. On sandflat and in estero (H).
Natica (Stigmaulax) broderipiana Récluz. One shell on beach (S).
Natica (Stigmaulax) elenae Récluz. Shell on beach of island (H).
Polinices (Polinices) bifasciatus (Gray). On sand inside sandspit (H).
Polinices (Polinices) uber (Valenciennes). On sandspit (H).
Polinices (Neverita) reclusianus (Deshayes). On sandflat (H,M,F).

Cypraeidae

Cypraea (Zonaria) annettae Dall. Under rocks in bay (H,M,F,S).

Eratoidae

Erato (Hespererato) columbella Menke. Shells from drift (H).
Trivia (Pusula) californiana (Gray). Under rocks in bay (H).
Trivia (Pusula) elsiae Howard and Sphon, 1960. One shell on beach at east shore (H).
Trivia (Pusula) solandri (Sowerby). Under rocks (H).
Jenneria pustulata (Solander). Shells on beach (H).

Ovulidae

Neosimnia quaylei (Lowe). On gorgonians in shallow water outside sandspit (H). Red- and white-shelled forms.

STROMBIDAE

Strombus galeatus Swainson. Shells on beach (H).
Strombus gracilior Sowerby. On sand near the sandspit (H,M,S).
Strombus granulatus Swainson. On sand near the sandspit (H).

CASSIDIDAE

Cassis (Semicassis) centiquadrata (Valenciennes). Shells on beach (H).

FICIDAE

Ficus ventricosa (Sowerby). Shells on beach (H).

CYMATIIDAE

Cymatium (Turritriton) gibbosum (Broderip). On rocks in bay (H).

MURICIDAE

Murex elenensis Dall. Shells on beach (H,M,S).
Murex recurvirostris Broderip. Shells on beach (H).
Hexaplex brassica (Lamarck). Reported by Boone (1928).
Hexaplex erythrostomus (Swainson). On sand near rocks (H,M,S,B).
Muricanthus nigritus (Philippi). One shell on beach (H). Apparently scarce.
Muricanthus princeps (Broderip). Immature specimen from islands (H).
Pterynotus erinaceoides (Valenciennes). On rocks in bay (H).
Ocenebra parva (E. A. Smith). One shell, from islands (M).
Eupleura muriciformis (Broderip). On rocks north of sandspit (H).
Eupleura nitida (Broderip). One shell on beach (H). Known range extended north from Mazatlan.
Muricopsis armatus (A. Adams). Shells on beach (H).
Typhis (Typhinellus) quadratus Hinds. On base of gorgonian (H).
Coralliophila (Coralliophila) hindsii (Carpenter). One shell on beach (M).
Acanthina (Acanthina) angelica I. Oldroyd. Abundant on rocks at mid-tide level (H, M, F, S).
Acanthina (Acanthina) tyrianthina Berry. On rocks of east shore (H).
Acanthina (Neorapana) tuberculata (Sowerby). On rocks (H,M,F,S,B).
Morula ferruginosa (Reeve). Abundant on rocks in bay and on islands (H,M, F,B).

COLUMBELLIDAE

Anachis coronata (Sowerby). On rocks, not common (H,M).
Anachis (Glyptanachis) hilli Pilsbry and Lowe. Scarce, under rocks (H).
Decipifus lyrta (Baker, Hanna, and Strong). One shell from drift (H).
Decipifus gracilis McLean, 1959. Under rocks in bay (H). Second record; described from Guaymas.
Mitrella delicata (Reeve). Shells in drift (H). Known range extended north from Manzanillo, Mexico.

Mitrella densilineata (Carpenter). Specimens from drift (H). Known range extended north from Cape San Lucas.
Mitrella dorma Baker, Hanna, and Strong. Under rocks in bay (H,M,F).
Mitrella granti Lowe. Drift specimen (H). Known range extended south from San Felipe.
Mitrella ocellata (Gmelin). Common on sand near rocks (H,M).
Nassarina (Zanassarina) pammicra Pilsbry and Lowe. Under rocks in bay (H). Known range extended north from Nicaragua.
?Nassarina, 3 spp. Three separable shells from drift (H;M;M). A genus close to *Nassarina* but lacking axial ribs.
Pyrene fuscata (Sowerby). Small specimens common in bay; large specimens on islands (H,M,F,S,B).
Strombina maculosa (Sowerby). Common on sand near rocks (H,M,S,B).

Buccinidae

Hanetia macrospira Berry. On rocks near sand (H,M).

Melongenidae

Melongena patula (Broderip and Sowerby). Reported by Boone (1928).

Nassariidae

Nassarius angulicostis (Pilsbry and Lowe). Shells from drift (H).
Nassarius versicolor (C. B. Adams). Shells on beach (M,S).
Nassarius (Arcularia) iodes (Dall). Inside sandspit (H).
Nassarius (Arcularia) moestus (Hinds). Common on sandflat (M).
Nassarius (Arcularia) tiarula (Kiener). Abundant on sandflat (M,F,S,B).

Fusinidae

Fusinus (Fusinus) dupetitthouarsi (Kiener). Shells on beach (H).
Fusinus ambustus (Gould). Bay rocks (H).
Fusinus (Aptixis) cinereus (Reeve). Common on and under rocks (H,M,B).

Olividae

Oliva (Oliva) spicata (Röding). On sandflat (H,M).
Olivella (Olivella) dama (Wood). On sand near rocks (H,M,F,S).
Olivella (Olivella) fletcherae Berry. Specimens from drift (H).

Mitridae

Mitra (Mitromica) solitaria C. B. Adams. Common under rocks in bay (H,M).
Mitra (Strigatella) dolorosa Dall. East shore rocks and subtidally off islands (H,M).
Mitra (Strigatella) mexicana Dall. One specimen on beach (H). The second record of this species.
Mitra (Tiara) erythrogramma Tomlin. One hermit crab shell (S). Known range extended north from Nicaragua.

Harpidae

Harpa crenata Swainson. Recorded by Boone (1928).

Volutidae

Lyria (Enaeta) cumingii (Broderip). On sand near rocks (H,M,S).

Marginellidae

Cypraeolina pyriformis (Carpenter, 1865). Common under rocks and in drift (H,M).

Cystiscus politulus (Carpenter, 1857). Abundant in drift (H).

Marginella californica Tomlin. Common under rocks in bay (H,M,B).

Marginella cf. *M. jewetii* Carpenter, 1865. A worn juvenile from drift (H).

Cancellariidae

Cancellaria (Cancellaria) obesa Sowerby. Shells on beach (H).

Cancellaria (Euclia) cassidiformis Sowerby. Seven specimens moving under sand on sandflat in March (H). Stalked egg capsules (identified by Dr. Gunnar Thorson) found on sandflat in June (M).

Turridae

Daphnella cf. *D. bartschi* Dall. One specimen, under rocks on west shore (M).

Knefastia funiculata (Kiener). One worn shell on beach (H).

Knefastia walkeri Berry. One specimen on beach (H).

Clavus (Cymatosyrinx) sp. One worn juvenile from drift (H).

Clavus (Elaeocyma) aeginus (Dall). Hermit crab shells on sandflat (M).

Clavus (Imaclava) pembertoni Lowe. Shell on beach (H).

Crassispira atramentosa (E. A. Smith). One specimen from islands (M). Known range extended north from Panama.

Crassispira nymphia Pilsbry and Lowe. Common under rocks (H,M,F,S).

Crassispira pluto Pilsbry and Lowe. Under rocks (H,M).

Mangelia (Mangelia) barbarensis I. Oldroyd, 1924. Specimens from drift (H). Known range extended south into the Gulf.

Mangelia (Agathotoma) phryne (Dall). Under rocks on west shore (H,M). Known range extended north from Panama.

Mangelia (Agathotoma) sp. Three specimens from drift (H).

Mangelia cf. *M. (Agathotoma) subdiaphana* Carpenter. Specimens from drift (H).

Clathurella (Lioglyphostoma) sp. One perfect specimen (H). Probably new.

Clathurella (Nannodiella) trichoides (Dall, 1919). One worn specimen with *Spondylus* (H).

Notocytharella niobe (Dall). Two specimens from drift (H). Known range extended north from Cape San Lucas.

Tenaturris nereis (Pilsbry and Lowe). Specimens from drift (H). This species is now known in collections from other localities in the northern Gulf.

Tenaturris phaethusa (Dall, 1919). Specimens from drift (H,M).
Tenaturris euryclea (Dall, 1919). Six specimens from drift (H).
Turricula (Fusiturricula) dolenta (Dall). One specimen on beach (H). Known range extended north from Panama.
Turricula (Fusiturricula) howelli (Hertlein and Strong). Two specimens on beach (H). Known range extended north from Costa Rica.
?Turricula sp. One worn specimen on beach (H).
Pleuroliria picta (Reeve). One specimen on beach (H).
Tiariturris spectabilis Berry. Three specimens on beach (H).

Conidae

Conus tornatus Sowerby. One specimen on beach (H).
Conus ximines Gray. On sandspit near cobbles (H).
Conus cf. *C. dispar* Sowerby. Worn specimens on beach (H).
Conus recurvus Broderip. Specimens on beach (H).
Conus regularis Sowerby. Worn shells on sandspit (H).
Conus cf. *C. scalaris* Valenciennes. Worn specimens on beach of islands (H,M).

Terebridae

Terebra (Microtrypetes) sp. One specimen with *Spondylus* (H). Probably new.
Terebra (Strioterebrum) variegata Gray. Just under surface of sand on sandflat (H,M,F,S).

Bullidae

Bulla gouldiana Pilsbry. Outer side of sandspit (H,M,F,S).

Akeridae

Haminoea angelensis Baker and Hanna. Inner side of sandspit (H).
Haminoea strongi Baker and Hanna. Inner side of sandspit (H,M).

Scaphandridae

Atys casta Carpenter. Specimens from drift (H). Known range extended north from Cape San Lucas.

Acteonidae

Acteon traskii Stearns. Specimens from drift (H).

Acteocinidae

Acteocina carinata (Carpenter). Common in drift (H).
Acteocina infrequens (C. B. Adams). Common in drift (H,M).
Sulcoretusa paziana (Dall, 1919). One specimen from drift (H).

Pyramidellidae

Pyramidella (Longchaeus) adamsi Carpenter. Five specimens from drift (H).
Odostomia (Chrysallida) viscainoana Baker, Hanna, and Strong, 1928. Under rocks in bay; common in drift (H,M).

Odostomia (Chrysallida) audax Baker, Hanna, and Strong, 1928. One specimen from drift (H). Known range extended north from Cape San Lucas.
Odostomia (Chrysallida) sp. One fresh specimen from *Spondylus* (H).
Odostomia (Pyrgulina) herrerae Baker, Hanna, and Strong, 1928. Specimens from drift (H,M).
Turbonilla (Chemnitzia) muricata (Carpenter, 1856). Two specimens from *Spondylus* (H). Carpenter's type was likewise on *Spondylus,* upon which this *Turbonilla* may be parasitic.
Turbonilla (Strioturbonilla) buttoni Dall and Bartsch, 1909. One specimen from drift (H).
Turbonilla, 3 spp. indet (H;H;M).
Iselica fenestrata (Carpenter, 1864). Three adults and one juvenile on *Spondylus* (H).

Placement of the genus *Iselica* in the Pyramidellidae has recently been suggested by Dr. S. Stillman Berry following Theile (1929, p. 233). The treatment is supported by study of *Iselica fenestrata,* which has a partially heterostrophic nucleus, a single columellar fold, and an operculum similar in shape and morphology to that of *Odostomia (Evalea)* sp., and which shows no indication of a radula in softened specimens. The present record of the species on *Spondylus* is also suggestive of the parasitism characteristic of pyramidellids.

Iselica cf. *I. ovoidea* (Gould, 1852). Specimens from drift (H).

Cavolinidae

Cavolina longirostris (Deshayes in Lamarck, 1836, *ex* Leseur MS). One specimen from drift (H).

Ellobiidae

Melampus olivaceus Carpenter. Common in beach drift at high-tide level (H,M).

Siphonariidae

Siphonaria maura Sowerby. Reported by Steinbeck and Ricketts (1941) [as *S. aequilirata* Reeve] to be common on rocks near sand. Not seen by us.
Williamia peltoides (Carpenter). Common on undersurfaces of subtidal rocks off islands (M).

Trimusculidae

Trimusculus reticulatus (Sowerby). Specimens from drift (H).
Onchidella binneyi (Stearns). Abundant under rocks at mid-tide level, exposed at night (H,M,F).

Class Amphineura

Lepidopleuridae

Lepidopleurus (Leptochiton) cancellatus Sowerby, 1839. Two specimens (H). Apparently not differing from this northern species, according to Mr. Smith, and thus extending the known range from southern California into the Gulf.

Ischnochitonidae

Ischnochiton (Radsiella) tridentatus Pilsbry. Four specimens (M).
Lepidozona clathrata (Reeve). Common under rocks (H,M).
Lepidozona subtilis Berry. Abundant under rocks (H,M).
Stenoplax cf. *S. aethona* (Dall). One specimen (M). Needs to be compared with the type of this species according to Dr. Berry.
Stenoplax limaciformis (Sowerby). Under rocks (H,M,B).
Stenoplax mariposa (Dall). Abundant under rocks (H,M,F). Many color phases.
Stenoplax conspicua sonorana Berry. Under rocks (H,M,B).
Lepidochitona keepiana Berry, 1948. One specimen (H). Known range extended from San Ignacio Lagoon into the Gulf according to Mr. Smith.
Callistochiton gabbi Pilsbry. Under rocks (H,M).
Callistochiton infortunatus Pilsbry. Under rocks (H,M).
Nuttalina crossota Berry. Four specimens under rocks in bay (H).

Chaetopleuridae

Chaetopleura lurida (Sowerby). Recorded by Steinbeck and Ricketts (1941).
Chaetopleura mixta (Dall). Described from Los Angeles Bay. Not seen by us.
Chaetopleura sp. A juvenile (M).

Mopaliidae

Placiphorella blainvillei (Broderip). One specimen found on a large *Pinna rugosa* (H). A new record, extending the known range north from Panama according to Mr. Smith.

Chitonidae

Chiton virgulatus Sowerby. Common under rocks (H,M).

Acanthochitonidae

Acanthochitona cf. *A. angelica* Dall. Three specimens (H). Needs to be compared with the type of this species according to Mr. Smith.
Acanthochitona exquisita (Pilsbry). Abundant under rocks at mid-tide level (H,M,F).

Phylum BRACHIOPODA

Class Testicardines

Discinidae

Discinisca cumingii (Broderip). Many specimens on *Spondylus* (H).
Discinisca strigata (Broderip). Equally abundant on *Spondylus* (H).

Terebratellidae

Argyrotheca lowei Hertlein and Grant. Four specimens on *Spondylus* (H).

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Fig. 2. A cove on one of the small islands near Los Angeles Bay, showing the steep intertidal zone composed of small boulders.

Fig. 3. The Vermilion Sea Field Station from low water line, showing the intertidal zone.

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TRANSACTIONS
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TWO NEW SPECIES OF BROAD-FACED, FIVE-TOED KANGAROO RATS (GENUS DIPODOMYS)

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The discovery of an isolated population of broad-faced kangaroo rats on the higher mesas of the Sierra San Borja in Baja California and another along the San Luis Rey River valley in northern San Diego County, California, is of outstanding interest. Thus two species are added to the mammal relicts whose ancestors must have once occupied much larger areas, but which are known only from a broken chain of small living populations in small restricted localities. Three such remnant mammalian populations in northern and central Baja California are (1) a chickaree, *Tamiasciurus douglasii mearnsi,* on the forested summit of the Sierra San Pedro Mártir; (2) a large broad-faced kangaroo rat, *Dipodomys gravipes,* on the low coastal mesas and plains about San Quintín; and (3) a striped chipmunk, *Eutamias merriami meridionalis,* known only from a very limited region of steep canyons and cactus-covered areas at 1000 to 1200 feet elevation about San Pablo, 25 miles north of San Ignacio. Two such species living in southern California are a broad-faced kangaroo rat, *Dipodomys stephensi,* in the arid Sonoran Zone in the San Jacinto Valley region of Riverside and southwestern San Bernardino Counties, and a large silky pocket mouse, *Perognathus alticolus,* in the pine-bracken softsoiled area at 5000 feet altitude in the western San Bernardino Mountains. Others could be named farther to the north, but these will suffice.

In March 1960, Mr. Glen Ives, then a staff member of the Natural History Museum, made a small collection of mammals at the San Juan Mine in central Baja California, Mexico. This collection included a new species of kangaroo rat (*Dipodomys*). This discovery led to a renewed interest in a specimen collected by the writer in 1920 near Bonsall, San Diego County, California, and called "an anomaly" by Grinnell (1922, p. 66). Two more specimens collected near Bonsall in the summer of 1961 show this "anomaly" to be a well defined new species. Both species are described below.

Dipodomys antiquarius sp. nov.

SAN BORJA KANGAROO RAT

TYPE.—Adult female; from the San Juan Mine, Sierra San Borja, Baja California, Mexico, alt. 4000 feet, lat. 28°41′N, long. 113°37′W; collected by Glen Ives, March 30, 1960; No. 18901, collection of the San Diego Society of Natural History.

DESCRIPTION.—*Dipodomys antiquarius* is a middle-sized five-toed member of the broad-faced *heermanni* group. The general dorsal coloration is light buff. The cheeks and area surrounding the eyes are lighter colored, almost white, this light area continuing to the ears and in some specimens extending around the ears to form conspicuous white areas behind them. The sides are much lighter colored than the back, the white of the under parts intermingling well above the break-line between the belly and the sides. The hip stripe is broad and white. The ears are blackish inside and behind, with buff-colored folded edges and scarcely any white on the tip of the pinna. The tail is moderately long, with white side stripes about as wide as the upper and lower black stripes, the white stripes extending well into the fairly large tail tuft. The arietiform facial marking is narrow, almost obscure, near the nose but is broad and black at the base of the longer whiskers. The eyelids are black and prominent in the light-colored facial area. The plantar stripes on the hind feet are well marked and black.

The skull of *D. antiquarius* has a slender rostrum with broad-angled, wide zygomatic arches. The jugals are straight. The mastoid bullae are well inflated but not to the point of crowding the interparietal into a deep sulcus. The auditory bullae are large and bulging, giving the skull its greatest breadth.

MEASUREMENTS OF TYPE.—Total length, 274; tail, 155; hind foot, 40; ear (dried skin), 10; greatest length of skull, 39.1; width across bullae, 26.1; spread of maxillary arches, 21.3; greatest length of nasals, 13.7; width of maxillary arch at middle, 5.1.

COMPARISONS.—The nearest relative so far known is *Dipodomys stephensi*, found only in the San Jacinto Valley region of Riverside and extreme southwestern San Bernardino Counties, California. *Dipodomys antiquarius* is about equal in size but is lighter colored dorsally and has whiter and lighter colored facial markings. The white tail stripes are as wide as the ventral and dorsal black stripes rather than narrower, as in *D. stephensi*, and they extend farther into the tip of the tail, making a much lighter colored tail tuft.

The greatest differences, however, are cranial. *Dipodomys antiquarius* has a more slender rostrum and slightly less angled zygomatic arches than has *D. stephensi*. The auditory bullae are larger and more swollen over-all, and the mastoid bullae are much more inflated. The pterygoid processes are heavier and not parallel like those of *D. stephensi*.

To *Dipodomys gravipes*, the only other broad-faced kangaroo rat found in Baja California, *D. antiquarius* shows but little resemblance except in the wide-spreading maxillary arches. In all respects, *D. antiquarius* is less robust within and without.

RANGE.—So far as known, the region, about 4000 feet altitude, at the San Juan Mine, in the Sierra San Borja.

REMARKS.—The isolated species in restricted spots southward to the mid-peninsula region, probably are remnants of wider spread former populations. The Pliocene submersion of the central peninsula and the volcanic and orogenic periods doubtless broke up the old populations and left many areas that were not reinhabitable by the small, less vigorous remnants. Possibly also, more vigorous

and better adapted species helped confine these relicts to circumscribed ranges. There seems but little doubt that the wide-faced character shown in several well-marked species of *Dipodomys* is very old.

Dipodomys cascus[1] sp. nov.

BONSALL RELICT KANGAROO RAT

TYPE.—Adult male; from 1 mile east of Bonsall, San Diego County, California; altitude 350 feet; collected by Laurence M. Huey, August 17, 1961; No. 18961, collection of the San Diego Society of Natural History.

DESCRIPTION.—*Dipodomys cascus* is a medium-sized, five-toed, broad-faced species and is also a member of the *heermanni* group. The dorsal color is light wood-brown with slightly paler cheeks, face, and sides. The lighter color on the sides does not extend as high toward the back as on some other kangaroo rats and is in sharp contrast with the white underparts at the break-line. The hip stripes are broad and white. The ears are small and are black inside and on the folded edges, with a conspicuous white tip on the end of each pinna. Above each eye is a prominent roundish white spot, 2-3 mm. in diameter. The eyelids are black and appear as rings around the eyes. The arietiform facial marking is black, broad, and heavy, extending from each whisker patch across the nose. The bicolored tail, which is noticeably heavy-boned in the flesh, is of medium length. The white side stripes are narrower than the black upper and lower stripes and extend well into the scantily tufted tail tip.

The skull of *Dipodomys cascus* has several outstanding characters. The mastoid bullae are only moderately inflated in breadth but are clearly bulbous and squarish when viewed posteriorly. The zygomatic arches are extremely widespread, closely rivaling the mastoid bullae in forming the widest part of the skull. This character gives a rounder appearance when viewed dorsally, rather than the triangular shape shown in the skulls of many other species of *Dipodomys*. The maxillary arches are exceptionally wide and the jugals are not parallel but are bowed outward at the middle.

MEASUREMENTS OF TYPES.—Holotype: total length, 272; tail, 158; hind foot, 39; ear, 10; greatest length of skull, 37.4; width across bullae, 24.8; spread of maxillary arches, 23.7; greatest length of nasals, 13.4; width of maxillary arch at middle, 6.1; weight, 68.5 gr. Female paratype (No. 18962, coll. San Diego Society of Natural History): total length, 270; tail, 156; hind foot, 40; ear, 11; greatest length of skull, 39.3; width across bullae, 24.8; spread of maxillary arches, 23.0; greatest length of nasals, 13.4; width of maxillary arch at middle, 6.1; weight, 64.0 gr.

COMPARISONS.—*Dipodomys cascus* resembles *Dipodomys agilis simulans* in general outward appearance. They live on common ground and must be closely examined to notice the slightly lighter dorsal color and smaller ears of *D. cascus*. However, when the skulls are compared, the two species are far apart and easily determined.

The nearest wide-faced relative is *Dipodomys stephensi*, found at the much

[1] =Old (Latin), in reference to its ancient lineage.

higher elevation of the San Jacinto Valley region north of the Palomar Mountain chain. Compared with *D. stephensi, D. cascus* is darker in over-all dorsal coloration and has a slightly flatter and wider skull, with wider spreading zygomatic arches and bowed jugals. Viewed posteriorly, the bullae of *D. cascus* are noticeably deeper and more squarish than those of *D. stephensi*. Compared with *Dipodomys antiquarius,* the wide-faced species from central Baja California, *D. cascus* is similar in size but decidedly darker in dorsal coloration. The skull of *D. cascus* differs from that of *D. antiquarius* in having less inflated bullae, more sharply angled and wider zygomatic arches, and bowed jugals.

RANGE.—Known only from a small area at 300 to 400 feet elevation in the San Luis Rey River valley east of Bonsall, San Diego County, California. The original specimen was from 5 miles northeast of Bonsall.

REMARKS.—The character that most impressed Grinnell in the one specimen he saw of *D. cascus* was the solid black tail. He also noted that the spread of the maxillary arches was 20.5 mm as compared to a mean of 22.5 and a range of 21 to 23.8 for *D. stephensi* but that the specimen was immature. These two characters caused him to call the specimen an anomaly: otherwise, he found it essentially similar to *D. stephensi*. Actually, the tail was solid black only because the preparator had accidentally spilled eternal ink on it; and the spread of the maxillary arches in both new specimens is greater than the mean for *D. stephensi*. Thus the two seemingly anomalous characters noted by Grinnell do not hold. However, the study of the two new specimens shows other differences, as detailed above, overlooked by Grinnell.

That this struggling relict population of kangaroo rats is still to be found in the tiny known range, where it has had to contend with poisoning campaigns and human agricultural invasion, is almost a miracle. Its future seems extremely doubtful, and before many years this species probably will pass into extinction.

It is also interesting to note that *Dipodomys cascus* represents another link in the chain of broad-faced kangaroo rats whose ancestors appear to have lived in past ages before the great Pliocene disturbances. Careful collecting by "seeing eyed" mammalogists probably will find other such restricted populations belonging to this broad-faced chain along the foothills in northern Baja California.

SPECIMENS EXAMINED

Dipodomys antiquarius. Baja California: San Juan Mine, Sierra San Borja, 8.

Dipodomys cascus. California: San Diego County—1 mi. e. of Bonsall, 2.

Dipodomys gravipes. Baja California: 3 mi. s. of San Telmo, 2; Santo Domingo (type locality), 19; San Quintín Plain, 14; Santa María, 1; near San Quintín, 2; San Quintín, 1; Agua Chiquita Canyon, 1. Total, 40.

Dipodomys stephensi. California: Riverside County—San Jacinto Valley, 1; San Jacinto Lake, 1; Ethanac, 1; Perris, 1; 4 mi. s. of Perris, 25. Total, 29.

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